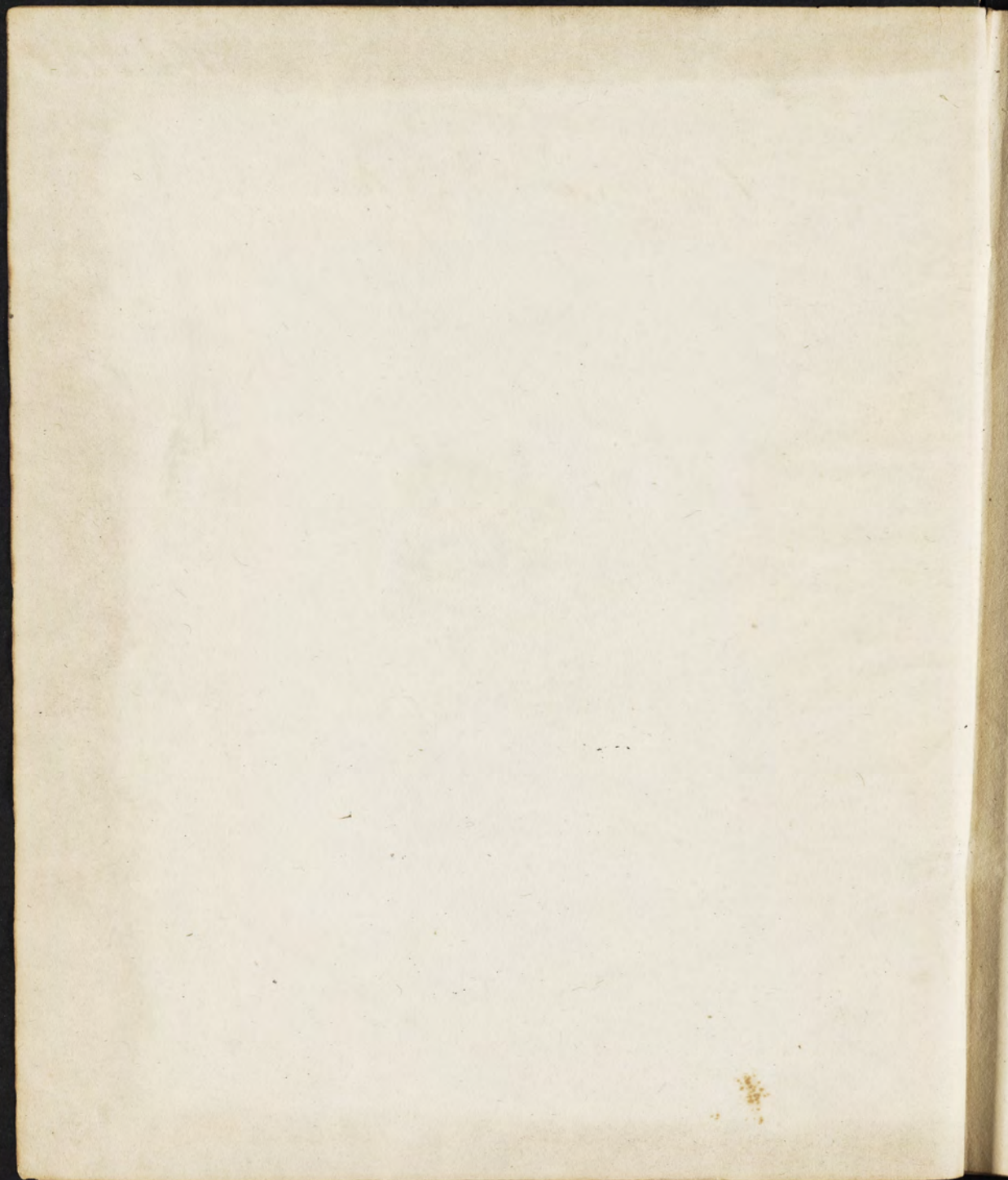




H. Lenox Hodge, M.D.

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W. A. Hodge.
1917.



Chemical Notes.

Being the Substance of a course
of Lectures delivered by
Thomas Cooper M. D.
in Philad^a during the Spring of 1847.

Taken by Hugh L. Hodge.

Vol: 2nd





Lectures on Chemistry by Judge Cooper. ^{154.}
Vol: 2nd
Alkalies.

There are substances of three kinds; one kind commonly termed Potash, Pearl-ash or Salt of Tartar, is contained in vegetable substances, viz. by Chemists called the vegetable Alkali. Another kind is Soda, or as it is more usually named the mineral Alkali. The third kind is the Volatile Alkali, known by the names of the Spirit of Hartshorn, & Spirit of Sal Ammoniac.

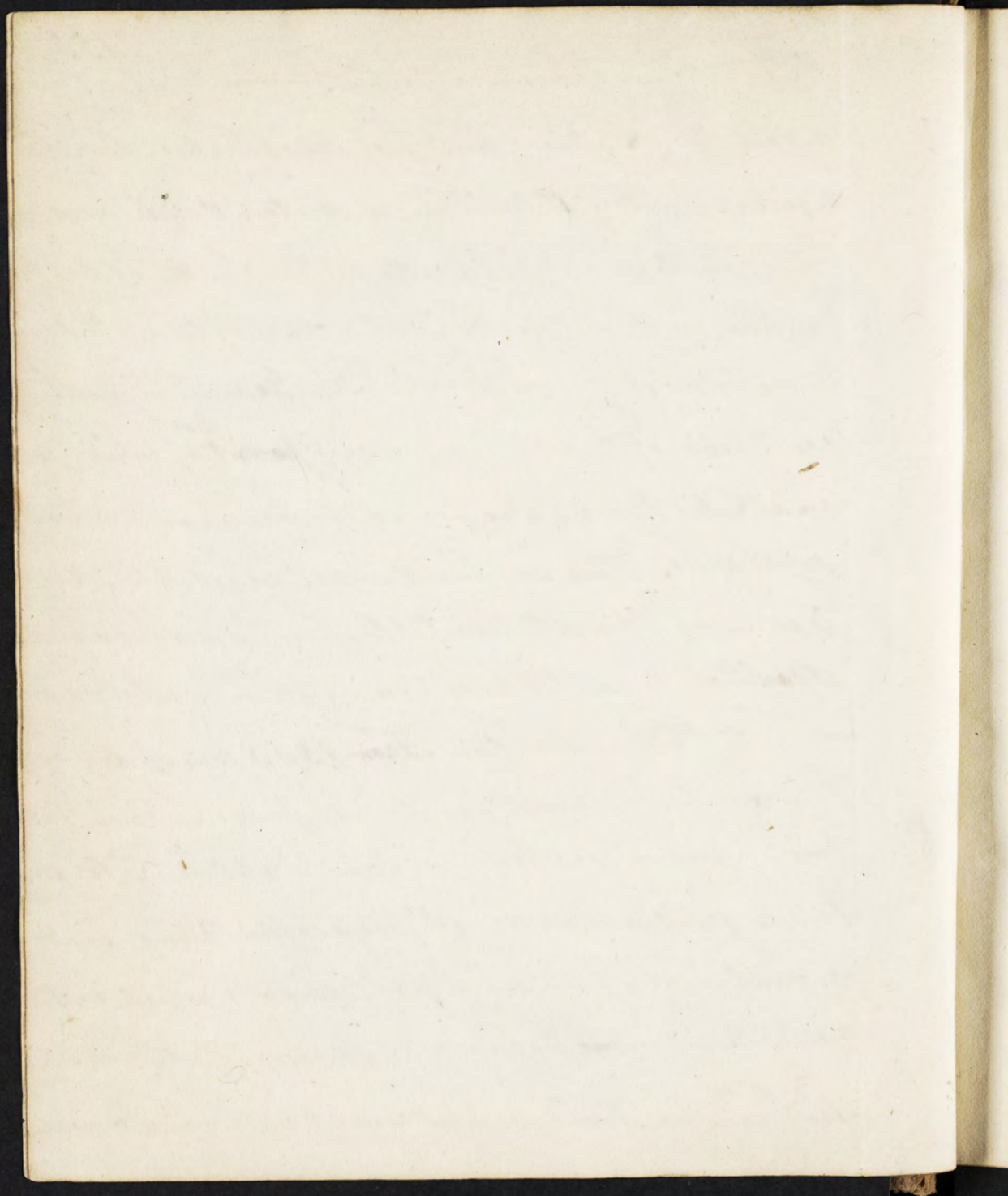
When I commenced the study of Chemistry I found great difficulty in procuring substances by their chemical names: that you may not encounter this difficulty, which is of no small importance I have explained & shall continue to explain the popular as well as the chemical names given to these substances. Thus as to Potash: if you want it in large masses, you must ask for Potash: if in a more moderate quantity per-
-her you can get it by the name of Pearl-ash. The purest kind is termed Salt of Tartar. If again you want the pure alkali, ask for the strong vegetable caustic or

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do

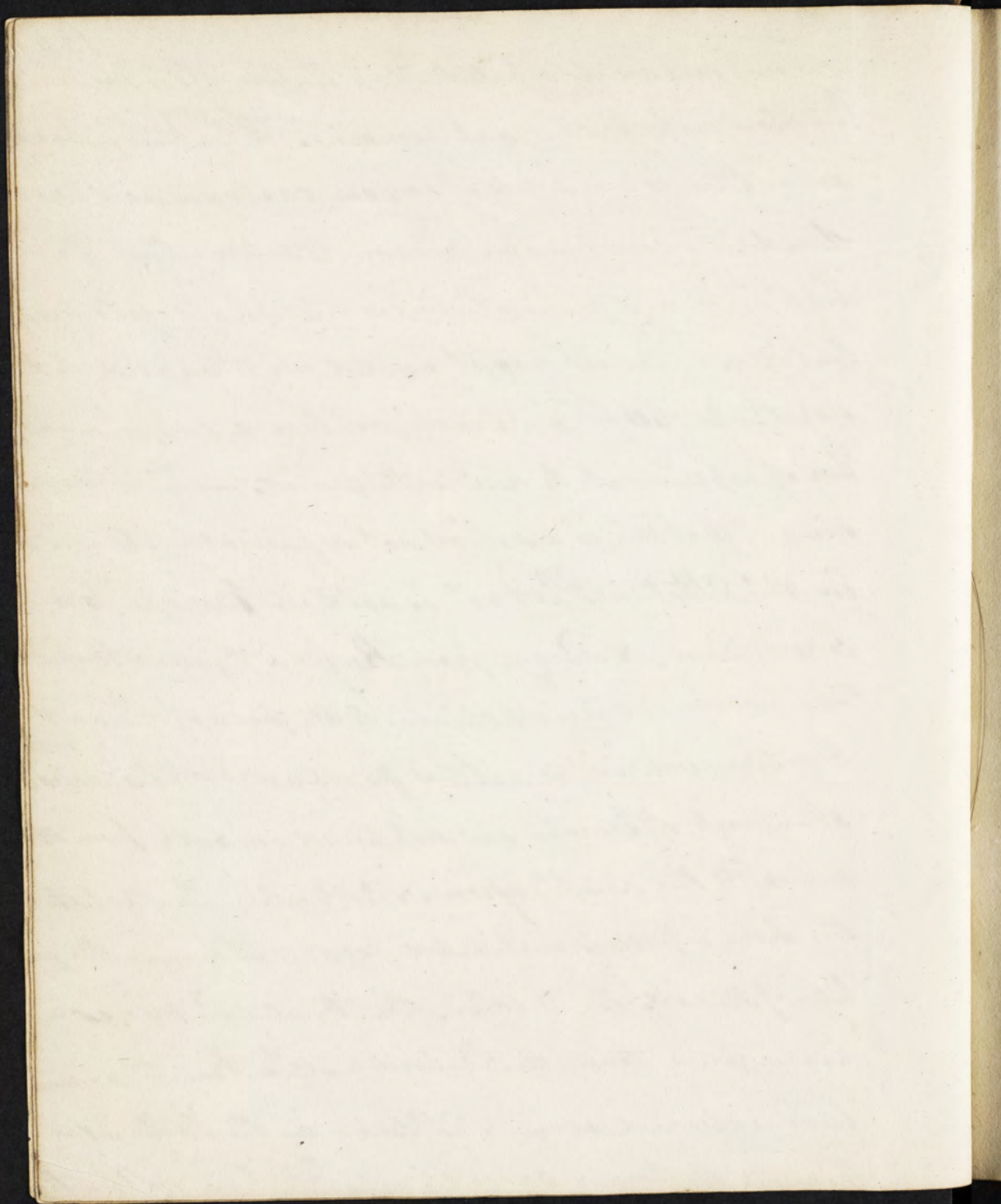
The causticum commune fastidius. — I shall now
detail the Natural History of the Alkalies — their Ar-
tificial History, their Chemical History & their uses —

The alkalies are as old as the earth. In the oldest for-
mation, in the substratum of the crust of the earth, so far
as we know it, they are found. The Granite is partly
composed of the feldspar — a component ^{part} of which is
an alkali: they are also found in numerous mineral
substances. They are found in all vegetables that
is when we burn the vegetable. For I am by no means
clear that the vegetable alkali exists in vegetables pre-
vious to their incineration. From 1800 tons of dry oak
there can be procured one ton of potash — from 1200
tons of Birch — one ton also can be obtained. Fir con-
tains a great deal more — A Grass called Burnet yields
a great deal of potash — all woods which contain
resin have ~~none~~ potash — or comparatively very lit-
tle. When Wood is first burnt — the acid & water

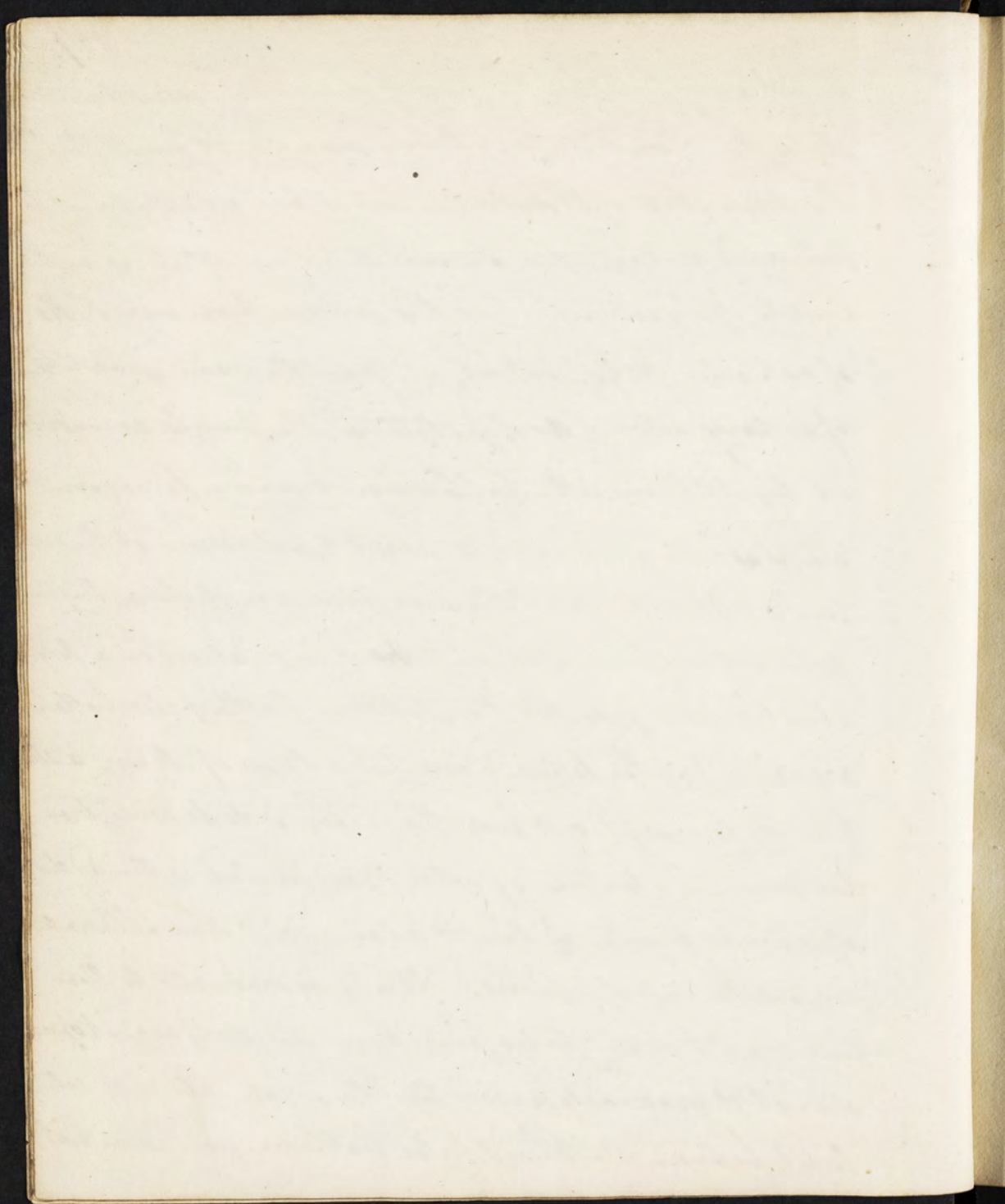
yes it
does



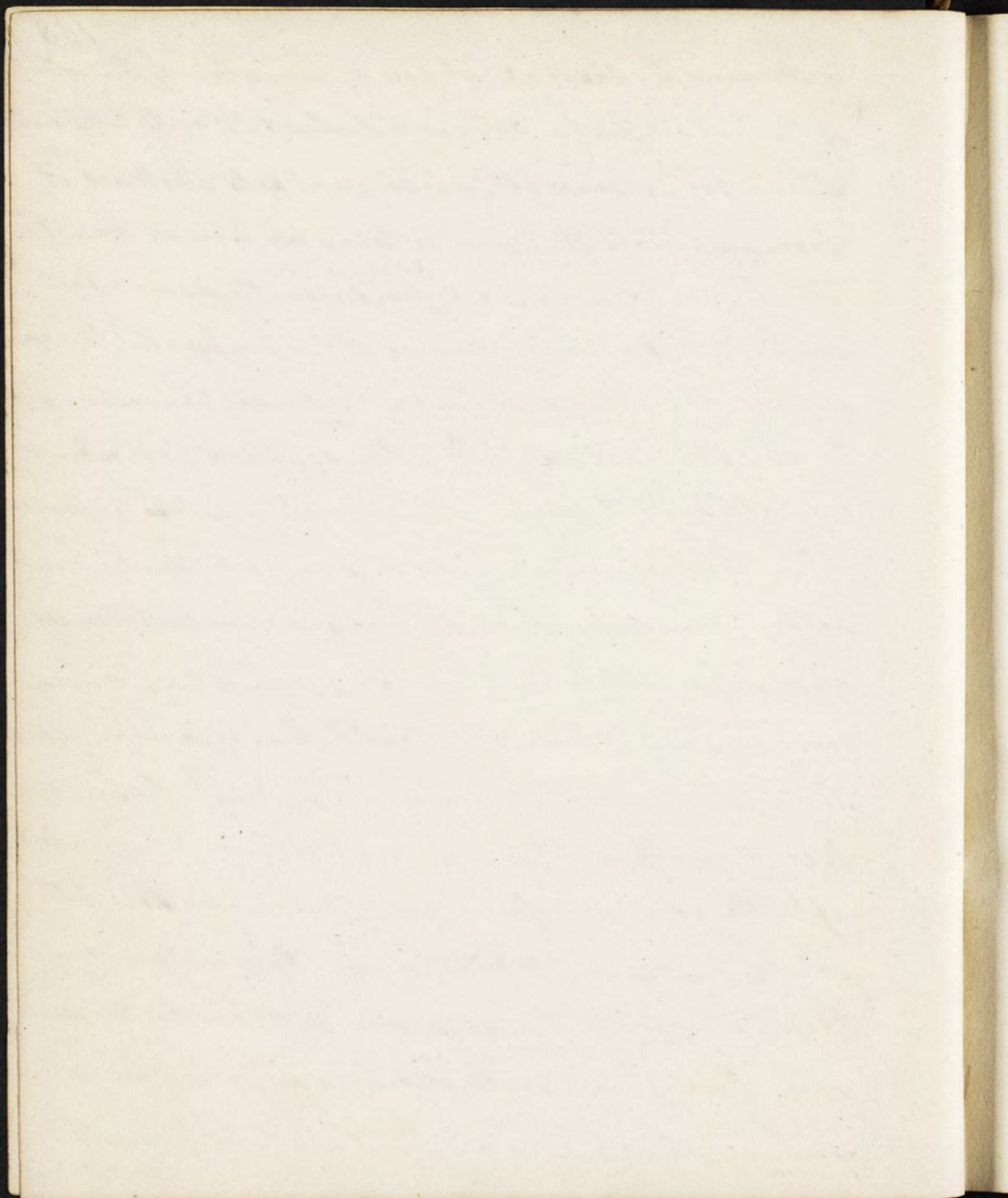
my vapours are dissipated. & if the process is conducted
 in close vessels, charcoal remains. When this is burnt
 where there is an access of oxygen, carbonic acid is pro-
 duced. There is some reason to believe that the al-
 kali is formed during the incineration of vegetables,
 but it may possibly exist united with an acid in the
 vegetable itself. There have not been a sufficient num-
 ber of experiments to decide this point. — The procu-
 ring of potash is a subject not sufficiently attended to
 in this State — Potash is sold in Europe, pro-
 cured from Norway, from Russia & from America.
 The former is carried chiefly to the ports of Briga &
 Dantzic — where it is called pearl ash, & blue ash.
 Other parts of Europe are supplied generally from A-
 merica & this chiefly from New York — In that state
 they have a process instituted for ascertaining the qu-
 ality of the article. & when thus treated it brings a
 higher price than the Russian — In Penn^a — as much
 land is cleared as in New York — in the latter state
 however the farmer saves his ashes. & I am certain the



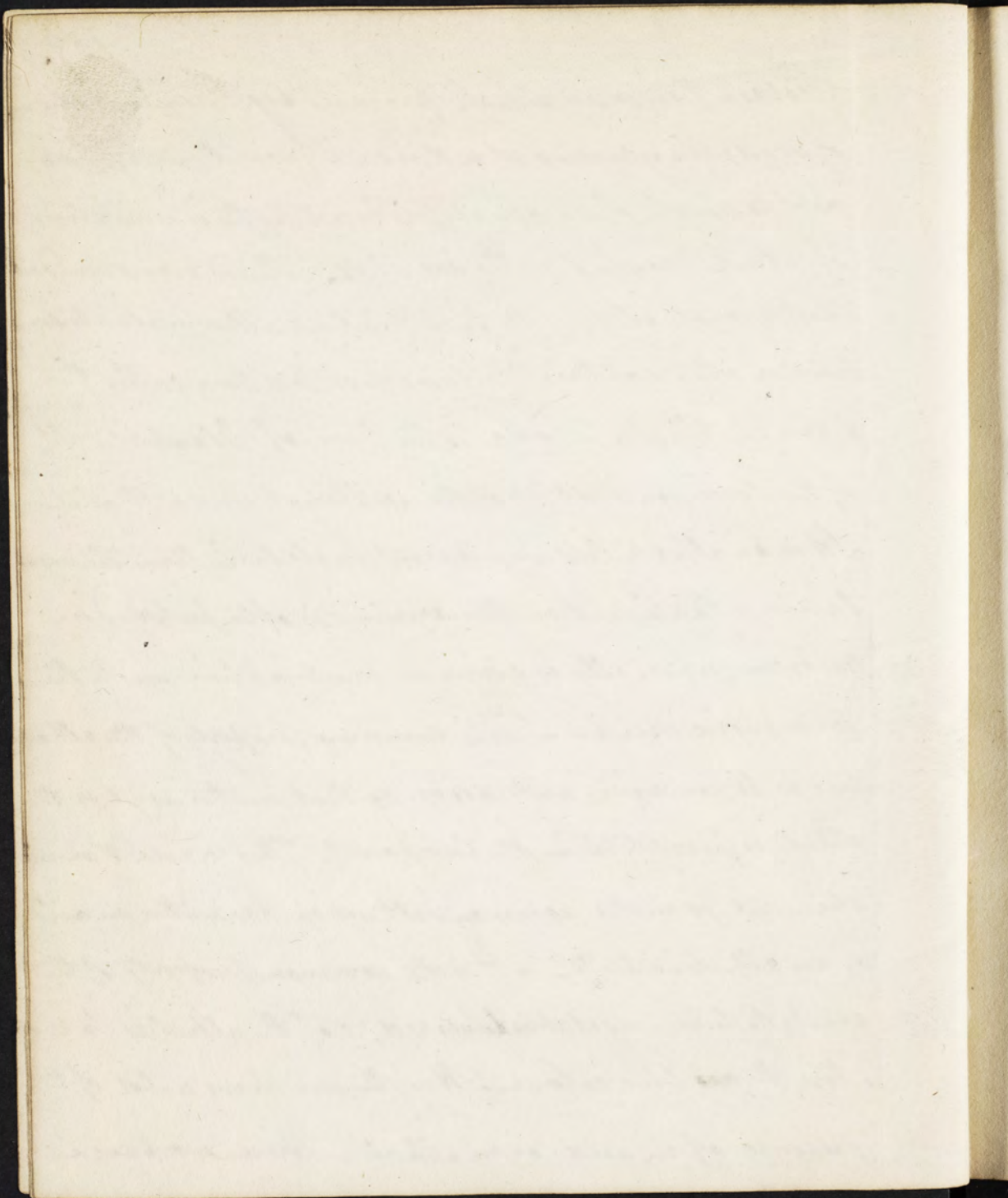
the ashes pay fully for the price of clearing the land; yet in this
 state the whole is entirely thrown away. At present thro'
 the whole state of Penn^a there is but one establishment for
 procuring pot ash. This was instituted by Mr Lewis in the
 County of Lycoming. There they procure from every 14 lbs.
 of oak ashes 12 lbs of pot ash - & from the same quantity
 of hickory ashes - 6 lbs of potash - The process, as conduct-
 ed by Mr Lewis is the following. Around a large room
 are placed a number of tubs - about 2 feet narrow at the bot-
 tom & 3 ft at the top. These are placed on dressers - they have
 false bottoms perforated with holes and placed on a ledge
 about 3 inches from the true bottom - On the false bottoms
 are laid poplar twigs - & over this a layer of straw - a str-
 atum of lime is placed over this, which is to be well trod-
 den down - a stratum of ashes 14 inches deep is then added
 afterwards 6 inches of lime & so on ashes & lime alternately
 till the vessel is filled. - Water is conducted to these
 tubs by a trough; being poured on the surface it spread
 over it & gradually passes thro' the whole till it is col-
 lected between the true & false bottoms - from which it



is drawn off clear: As it goes on very slowly the whole
of the pot ash in the ashes is dissolved - & as the affinity
of Lime for carbonic Acid is so great as to abstract it
from an alkali the liquor is tolerably pure or caustic.
This liquor is conducted to ^{iron} boilers in the same apart-
ment - then it is boiled down: When evaporated to a con-
sistence the heat is greatly raised & the carbonaceous mat-
ter is chiefly burnt out - It is then suffered to harden &
is finally dug out - packed up in barrels & sold as potash.
When pearl ashes are wanted it is subjected to a reverber-
atory furnace by which the carbonaceous substances
are more completely expelled - As pursued here & in com-
-merce generally it much adulterated - Thus in a manufac-
tory of oil of vitriol at Manchester in Eng^d I learnt
that the sulphate of potash & sulphuric acid of potash left
after the acid was formed - was washed so that all
soluble matter might be dissolved - this was then crys-
tallized & sold to the Valters who added it to their pearl
ashes. In this way adulterations go on - & therefore when
you ^{with} any thing pure - you must make it yourself -



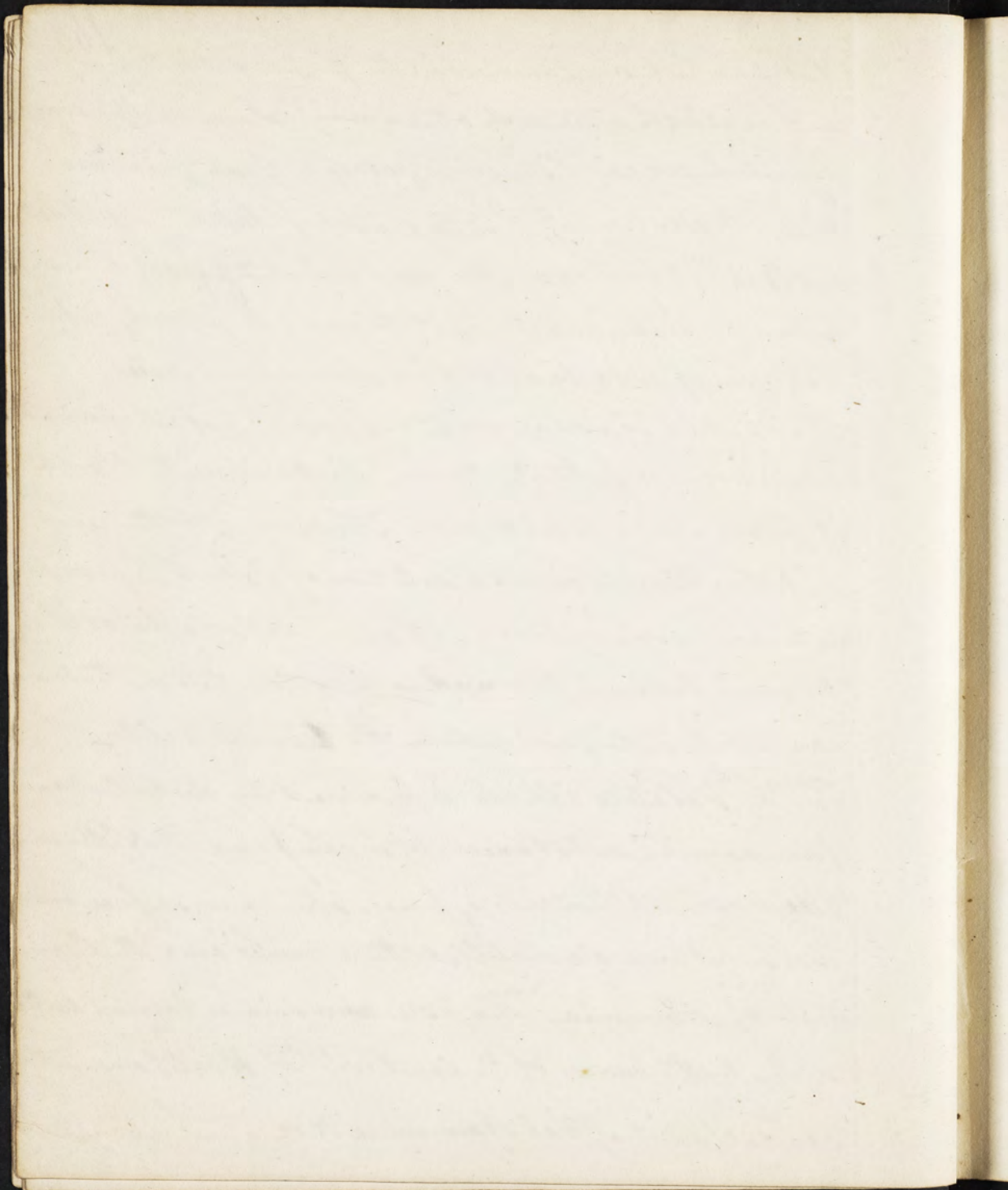
Potash then is an alkali-procured by the incineration of vegetables growing at a distance from the sea; I am next to speak of an alkali produced by the incineration of plants growing by the sea side. This is very abundant in the whole class of the fasci. Indeed all sea-plants some now or other contain Soda - which has been called the Mineral alkali. Soda is the base of Glauber's salt, of the Common Salt, & of the artificial Soda Water. It is an alkali less unpleasant in its taste than the vegetable alkali and on this account is often preferred in medicine, especially as given in combination with the Phosphoric Acid. - The common property of the alkalis is to combine with acids - so that neither acid or the alkali is perceptible in the compound. Thus Soda & muriatic acid form the common salt, which has neither an acid or an alkaline taste. - It is the common property of the acids to turn vegetable blues red, & of the alkalis to restore the ~~red~~ blue colour. Here then we have a test of the presence of an acid or an alkali. Hence we have a



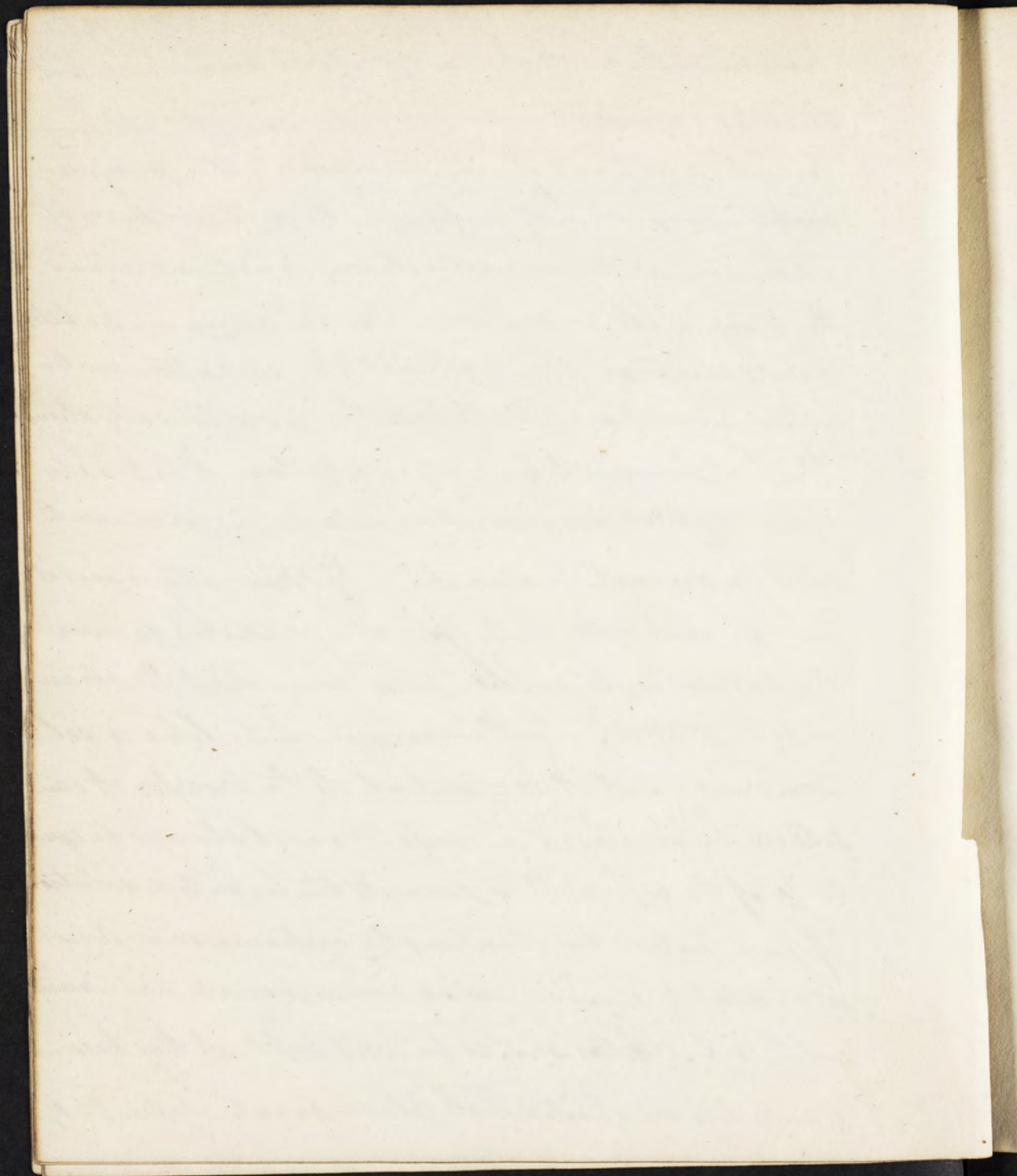
test by which we can discover the perfect saturation of an acid or alkali with each other - There are two ways by which we can distinguish potash & Soda from each other, A solution of Platina is precipitated by potash but it is not by Soda. Thus add solutⁿ potash to a solution of Platina - a precipitate will be formed, but if a solution of Soda be added no change will ensue.

The acid of Tartar with one part of potash forms a very insoluble salt - the Cremor Tartari: with Soda it forms a very soluble one. Therefore if to the acid of tartar there be added a solution of Potash - a precipitate will soon appear - but should Soda be added no precipitation is produced - By these two methods we can readily distinguish between the ~~two~~ Alkalies -

The Volatile alkali is procured by distillation from animal substances - it is composed of Nitrogen & Hydrogen - When Hoofs, bones - skin or any refuse animal substance are distilled there comes over the Carbonate of Ammonia. The pure ammonia is known in the shops by the names of the Caustic ^{pt} of Hartshorne - the caustic Spirit of Sal Ammoniac &c. The carbonate is

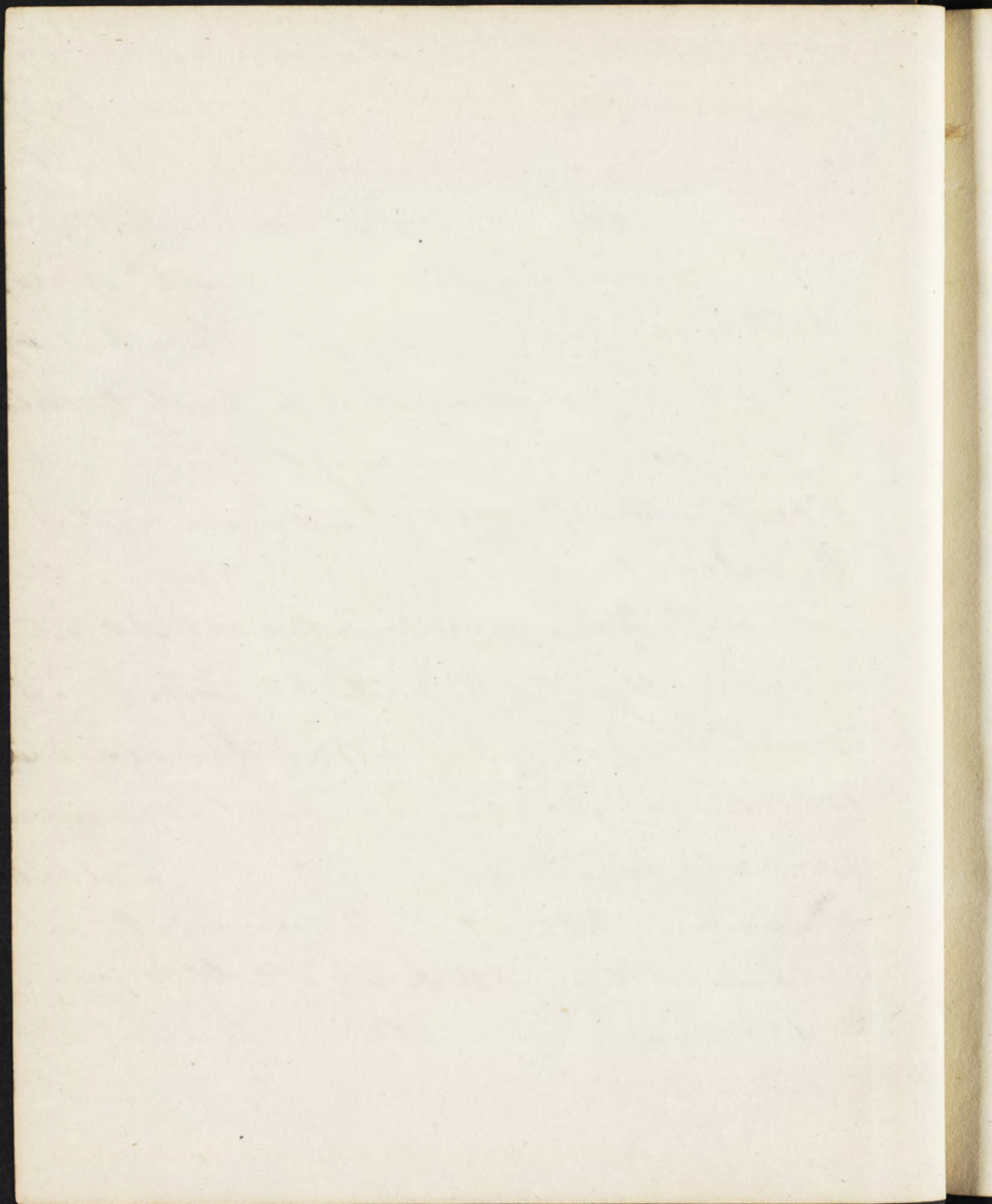


known by the name of the Sp^t of sal ammoniac - vol-
smelling salts &c &c — — — The uses of the alkalis
form the next point of consideration. The processes of
making soap are not uniform in the different parts of
the country, as they in most instances, do not understand
the theory of its formation. In the common lye tubs
ashed & straw are placed alternately on each other - water
is then poured on till the solution is sufficiently strong.
It is best however to have a false bottom 2 or 3 inches
above the true one, which should be perforated with
holes $\frac{1}{2}$ an inch in diameter - If straw only is used it
is soon destroyed by the lye - it is preferable to cover
the bottom with poplar twigs - over which the straw
is to be placed. In the common tubs lime is sel-
dom used - but it is essential to the process: it can
seldom be employed in excess - & ought always be equal
to $\frac{1}{3}$ of the whole. This converts the lye into a solution
of pure potash by absorbing the carbonic acid; which
is absolutely necessary as no subcarbonate will unite
with oil. Ashes should be well kept - if they become
clump they are spoiled - A place ~~pre~~ entirely built of



bricks is the best. When soft soap is wanted 162.
the fat & solutⁿ of potash are merely boiled together, if
hard soap the process is very easy, as soap will not dis-
solve when boiled in a solution of a neutral salt - if you
boil a solution of common salt with a solutⁿ of soap,
it will become hard & will separate. In making soap
however the great object should be to separate the carbonic
acid from the lye by means of the lime -

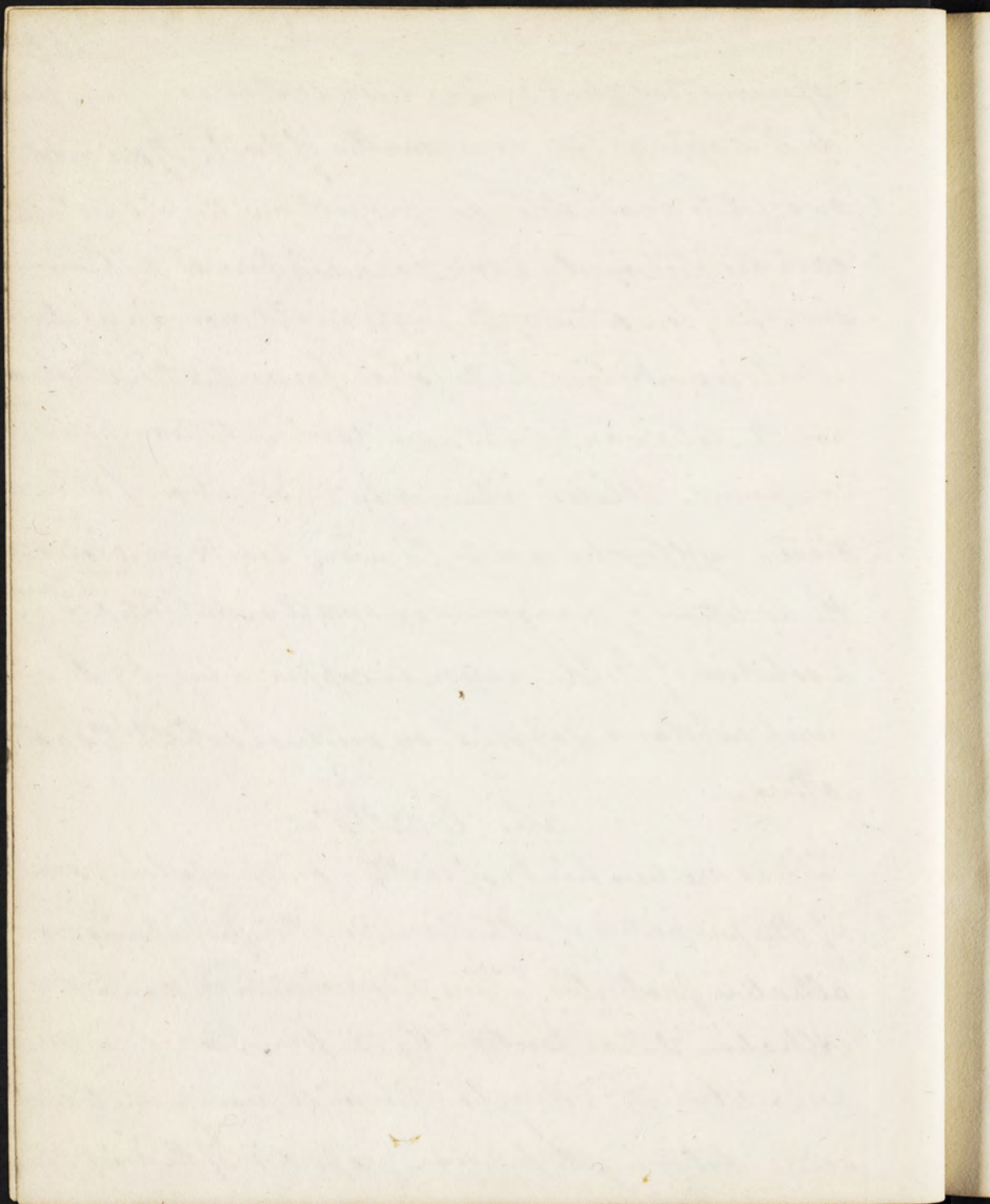
Equal portions of pot ash & lime mixed together &
then melted - the mass being then ground & again melted
in glass. The proportion to the purity of the arti-
cle employed will be the purity of the glass. When it
is wanted very pure a portion of red lead is added which
easily parts with its oxygen. There is a singular circumstance
occurs - when lime is used to remove the carbⁿ acid & still
some remains with the pot ash this carbⁿ or rather sub-
carbonate will injure the purity of the glass - forming
nodes or specks in it - none of it will unite with the silica
but if red lead be added the whole of its oxygen unites &
combines with the glass. All this has given rise to the



opinion that flint sand or silix contains oxygen - Indeed it appears to be so in matter of fact: If we add an acid to an alkali in due proportions, the properties of each are destroyed - a compound is formed differing essentially from either of the ingredients: now in glass the alkali is neutralized by the silix - for neither the alkali nor the silix can be distinguishable in the transparent compound. Glass is coloured by the addition of other substances - yellow by anty by silver, lead &c - violet by the addition of manganese in small quantities: red by a solution of Gold - green by copper: blue by the mineral substance Sapphire - an oxide of cobalt: & so of others -

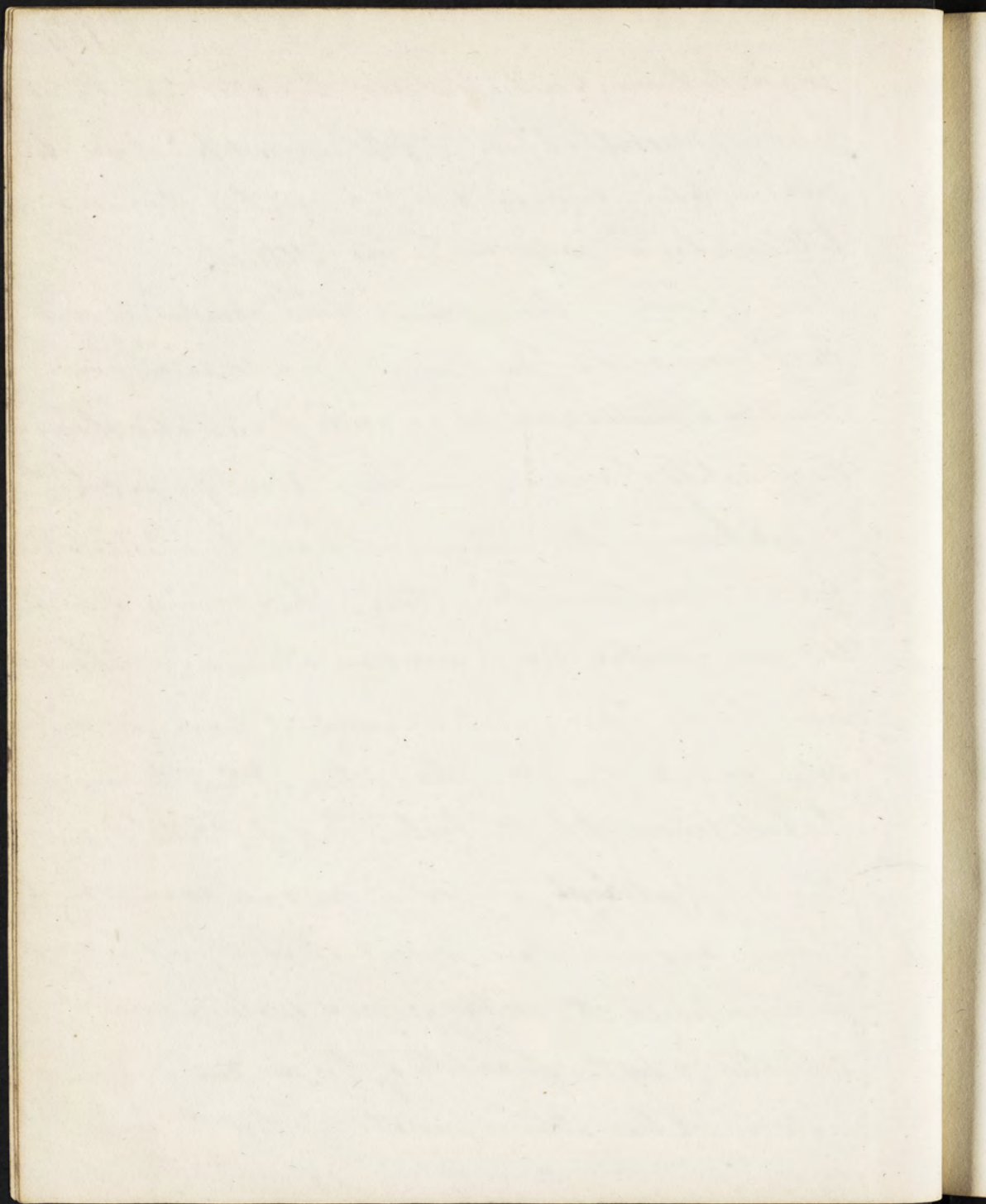
The Earths.

There are two kinds of earths - one possessing some of the properties of alkalies - the other possessing no alkaline properties. Thus they are divided into the Alkaline & Pure Earths - Of the former are Lime, Magnesia Strontia & Barytes - these will readily unite with acids - destroying the peculiar properties of the acid & form

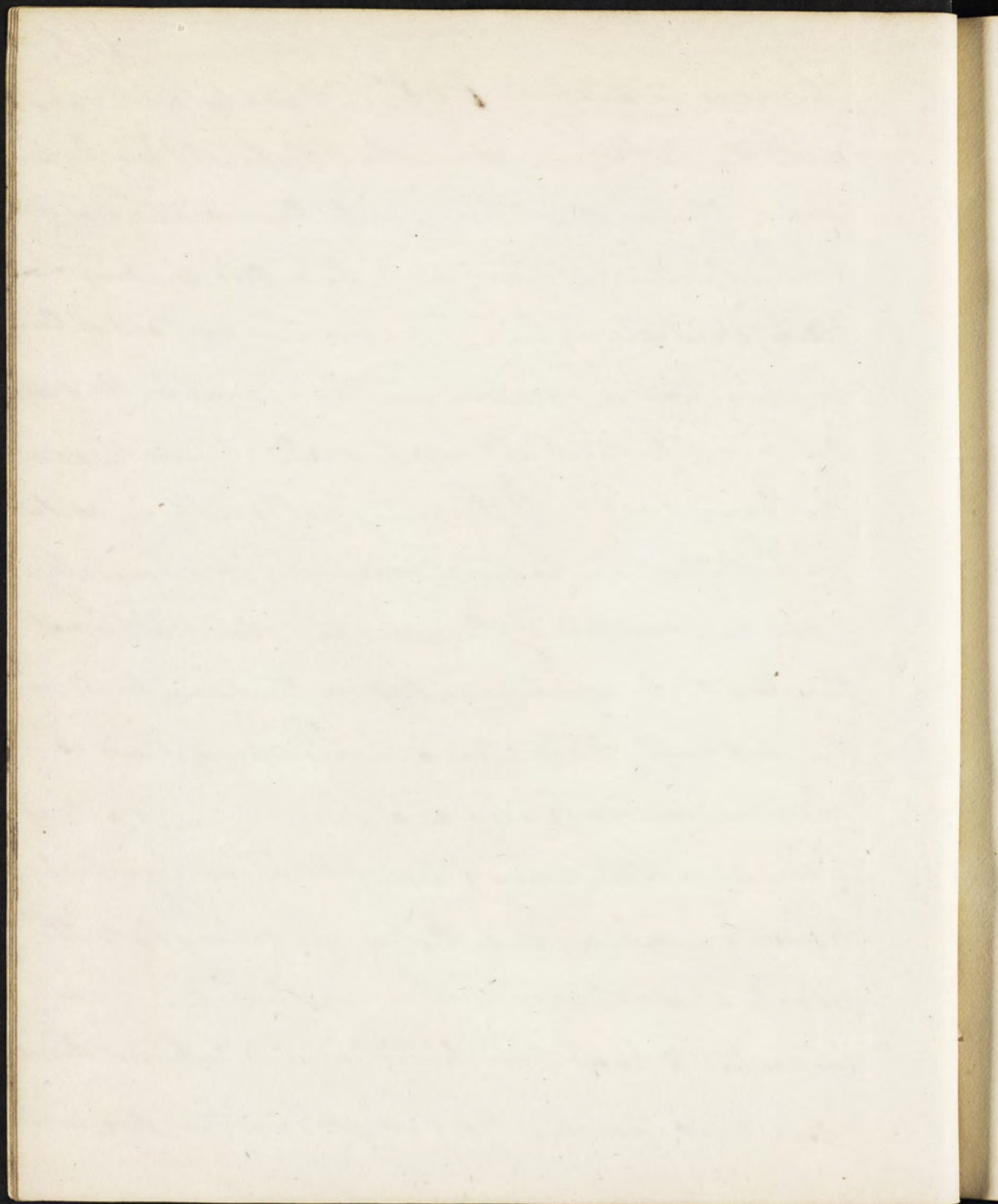


ing with them Neutral Salts. They also turn the red colour of vegetables blue. Of the second kind are the mine or Clay, Silica or Flint & 3 or 4 others of which very little is known: as Zircon Glucine & Titania.

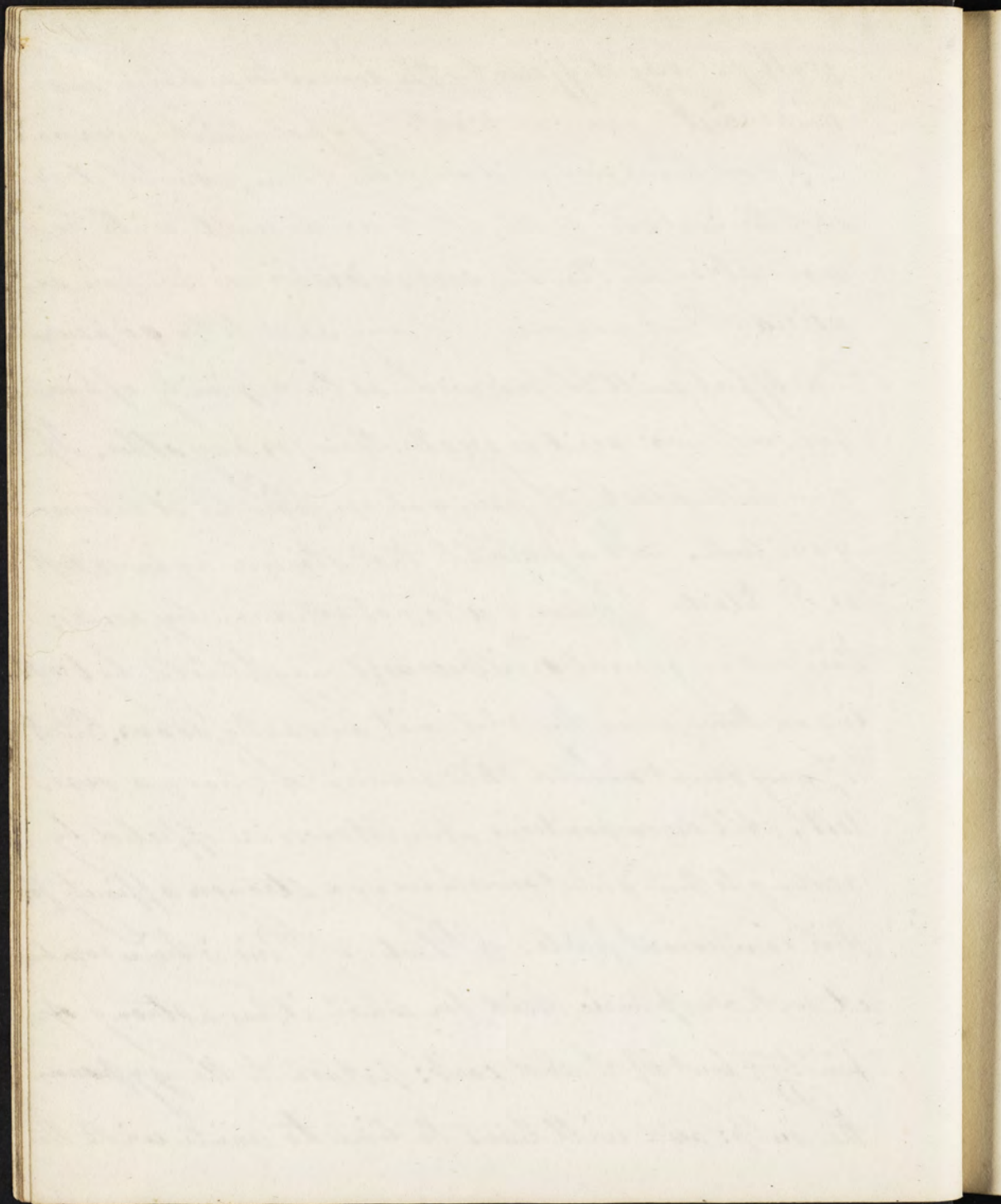
First of Lime. Lime-stone is Lime combined with the carbonic acid. I have on a former occasion ^{stated} how it could be separated viz by an acid. I have also shown the quantity of acid in lime stone about $\frac{1}{4}$ p. cent. I do not know whether I then pointed out the utility of that mode of decomposing lime stone. Supposing I wish to know whether there is any lime stone on a plantation I take a piece of the mould - I burn it - dissolve or mix it with water - & then if there be any lime I shall know it by the taste. But if I take some of the earth & place ^{it} in a retort - pour on it some acid - if there be any lime-stone present - it will in this way be decomposed - the carbonic acid evolved may be collected, & by the quantity of this we can calculate how much lime stone is present. So that the weight of the acid becomes the exponent of the Lime.



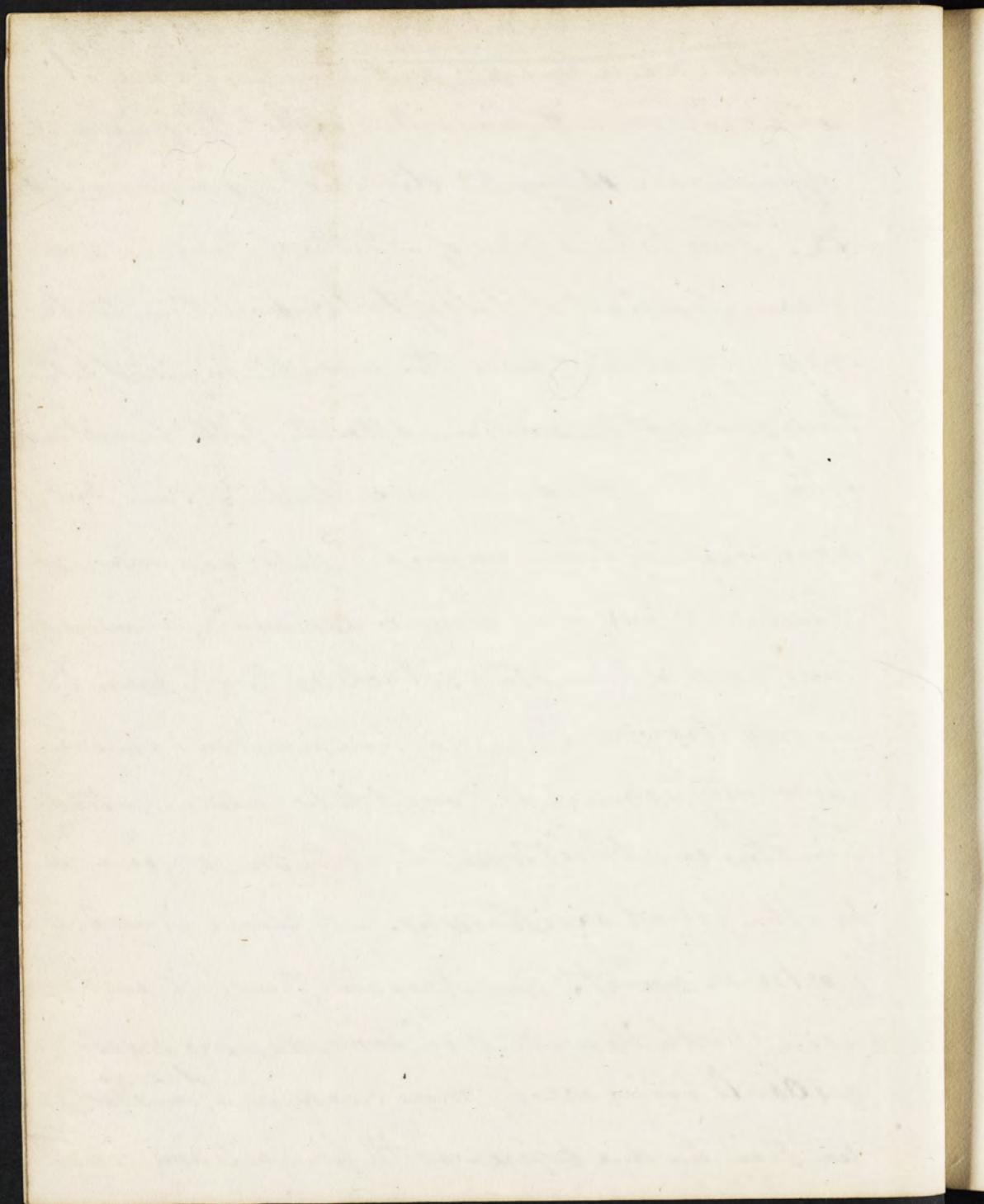
Lime is an alkaline Earth. It unites with Acid, with the Sulphuric forming the Plaster of Paris, Gypsum or Sulphate of Lime; with the muriatic acid producing the Mur: of Lime; with the nitric making Salitre, or Nitrate of Lime. The most important of these combinations is gypsum. This is found in the same relative situations all over the earth: it usually accompanies Rock Salt, running not exactly in contact with it - but in the neighbourhood: it is generally before the formation of the red-sand stone. It is not therefore to be expected unless in the same parts as the rock salt - & red stone. - Plaster of Paris is used in stuccoing: also as a manure, here it acts as a stimulus to the living fibres of the plant - by which its powers are increased - but it is not taking into the plant - it is not food - but a condiment. It will be useful to know how to distinguish between Lime Stone & Gypsum. If you scratch them they will



will feel very different - the Limestone being much
 the hardest - you can scratch gypsum with your nail
 If you pour any acid on Limestone, it will drive
 out the carbonic Acid, all the acids unite with lime
 more strongly than the carbonic which is therefore ex-
 pelled. But you may add any acid to the gypsum
 No effect will be produced - as the affinity of lime
 for sulphuric acid is greater than for any other. If
 you bite plaster of Paris you can powder it between
 your teeth. It is possible, that stones may be as soft
 as the plaster of Paris & also not acted on by acids;
 these are in general argillaceous, & may be told by break-
 ing on them when they will emit an earthy odour. But
 if any doubt should still remain we have a sure
 test. All decompositions of substances are effected by
 adding to them substances having a stronger affinity for
 their component parts. Plaster of Paris is some combi-
 ned with Sulphuric Acid, for which it has a strong af-
 finity; but if I add carb: potash to the gypsum
 the sulph: acid will leave the lime to unite with the



potash - while the carb. acid being thus set free ^{167.}
will unite with the lime - Thus altho' the quiescent
affinities are strong, the divellent affinities are stron-
-er. Thus take a piece of Plaster of Paris, add to it
3 times its weight of salt of tartar - boil them to dry-
-ness - repeat this 3 times, then wash them on a filter
the liquor; if the substance left on the filter be carbonate
of lime, then the body tried was a plaster of Paris but if
no carbonate of lime remains, the substance was not
Plaster of Paris. — Lime is a manure, when used
pure & not as lime stone: it acts as the Gypsum be-
-ing only stronger. The use of lime is not in vogue in
this country, as much as it ought to be: even in what are
lime stone countries it is useless, as the surface is in reality
often found argillaceous. — Lime is used as a
mortar or cement. Here it regains partly its carbonic
acid & partly its water, & in some measure crystallizes
as all bodies occupy more room in a ^{states} crystalliza-
tion, than they did before - so the lime acts as a cement

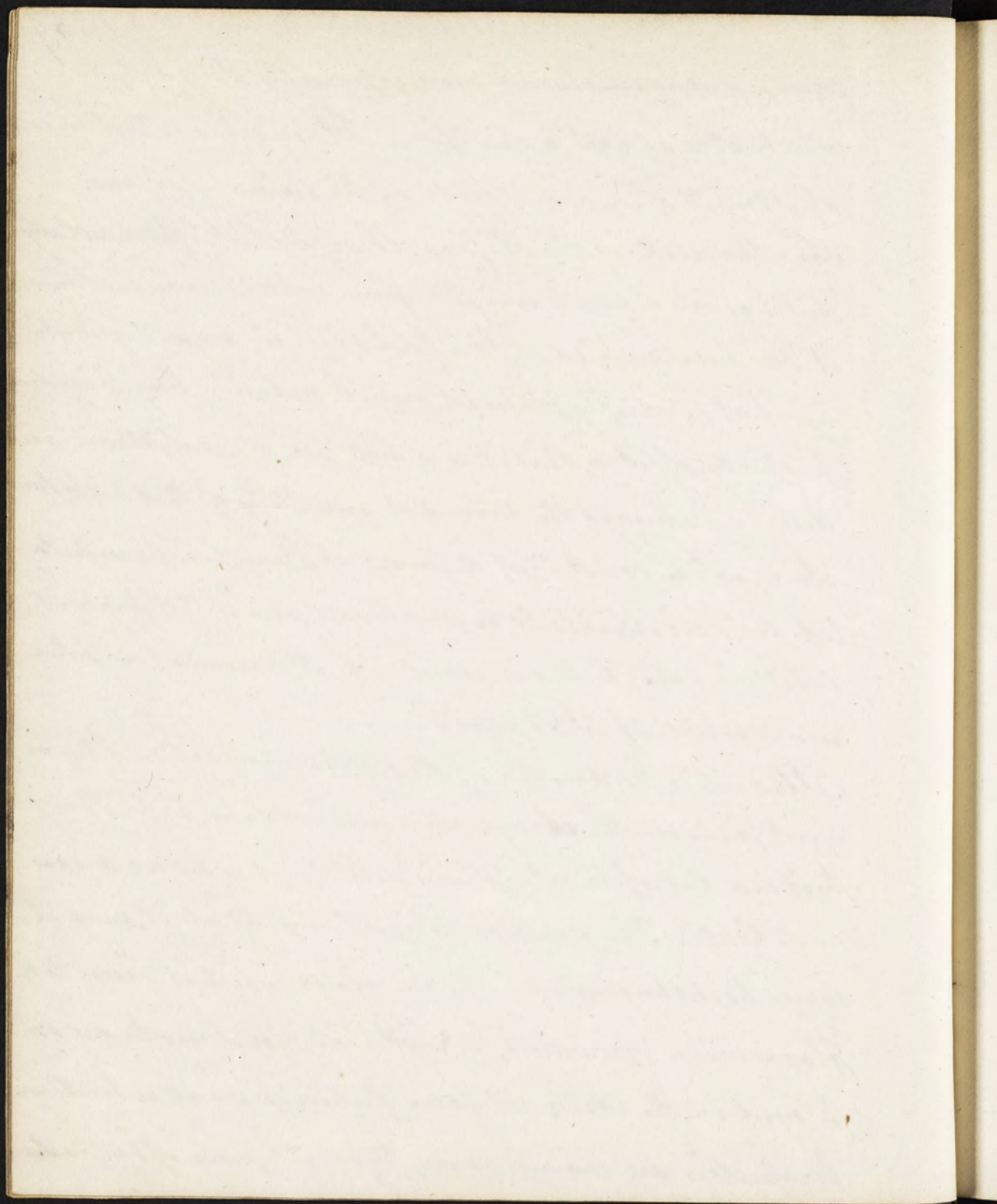


by enlarging the surfaces of contact & penetrating every
 crvice. — The second Alkaline earth is the
 Magnesia: this we get from the mother water of
 common salt - after all the salt has been separated by
 crystallization; in this case there remains in solution
 another salt which is usually the muriate of Mag-
 nesia. Where it comes from I know not - unless it
 is that the sea washes the edges of some formation
 which contains it. After common salt is separated
 from sea water we have a solution of mur: of mag-
 nesia, which will not deposit crystals. If we then
 add a substance containing sulphuric acid, Epsom
 salt will be formed - which in its turn may be de-
 composed by the carb of Potash. The Carbonate of
 Magnesia is thus obtained. As a medicine no sub-
 stance is so useful: the carbonate is tasteless, & do
 not mix so well with the fluids as the pure earth.
 This is procured by heating the carbonate till all the
 acid is driven off - it thus loses 9 parts out of 20
 & is now called magnes: usta. It is very serviceable
 in indigestion, from which almost all our diseases



arise - as rheumatism & more especially the gout, for which it is almost a specific - It is very useful in case of Stone & other complaints of the urinary organs. Another earth of this class is Barytes. This particularly distinguished by its weight - from which circumstance it has been named. It is found here in small quantities - but is chiefly procured from England. One peculiar property of it is, that it is a test for the sulphuric acid detecting always the minutest quantity of that substance. In Eng^d the solidⁿ of the muri. of Barytes is precipitated by Vol: Alkali - & is employed as a white pigment which is said to be very excellent. I know of no other use to which it is applied.

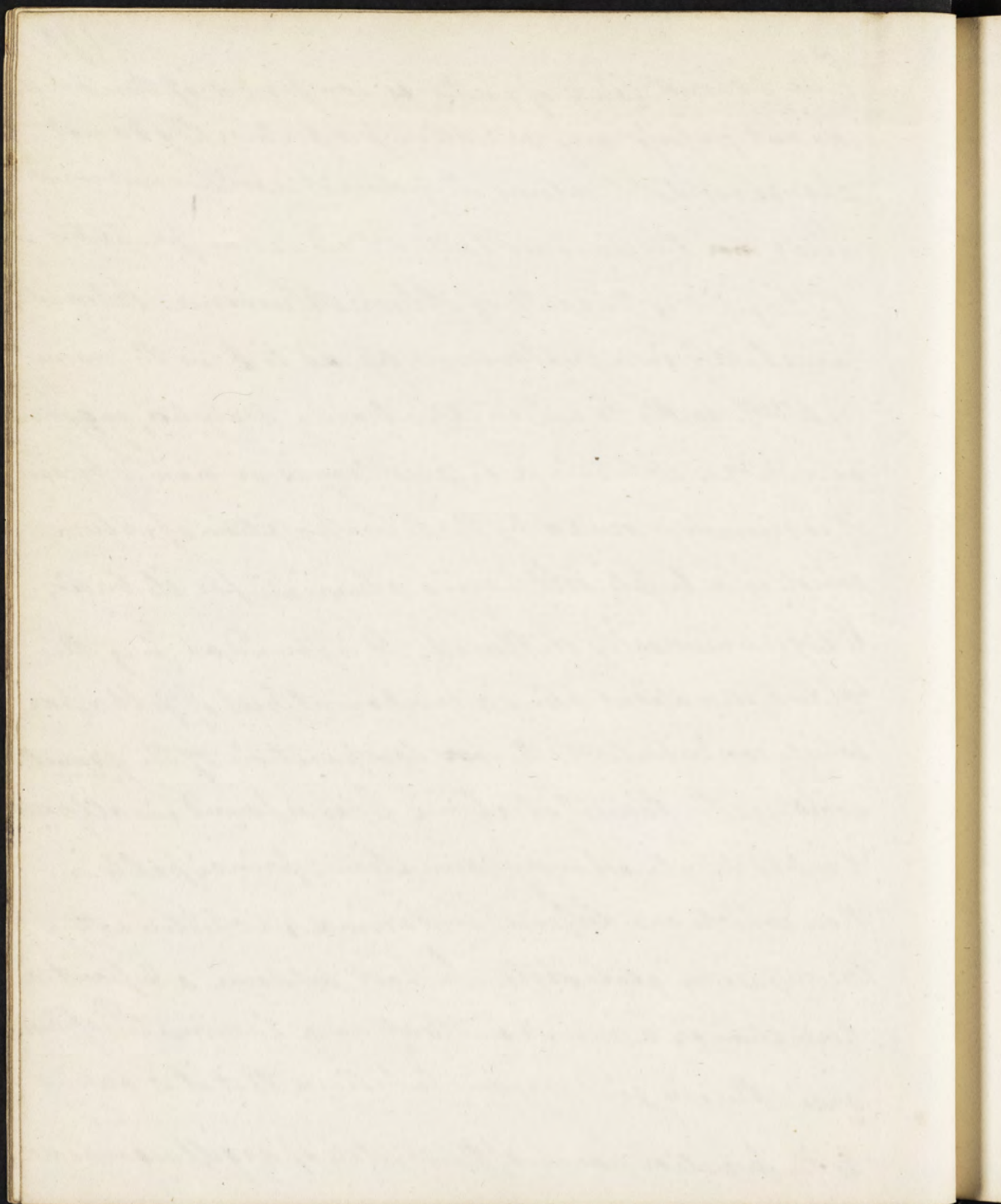
Strontia is another of the alkaline earths. It was first found in the Argyleshire in Scotland. Like Barytes it is a test of the Sulphuric acid but is by no means so delicate. The peculiar property by which it may always be distinguished is the red colour which it gives to a flame when it is burnt. & either it nor Barytes are employed in the arts: at some future period when their properties are more known, they will prove of importance.



The second Class of earths is composed of those which do not possess any alkali properties: they do not change vegetable colours, they do not readily combine with acids, ~~and~~ they have no taste & no saline properties -

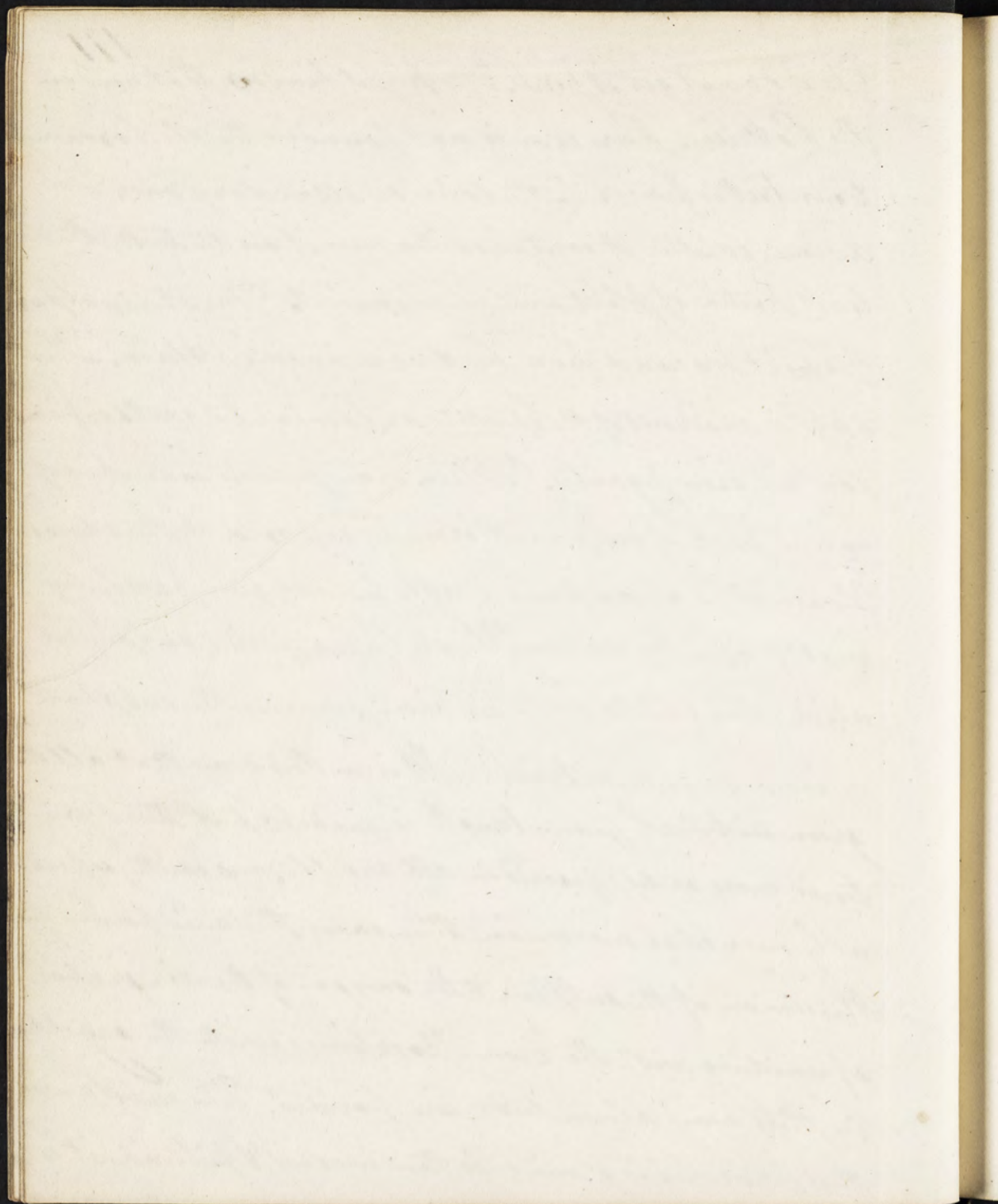
The first is the earth of Alum: Alumina - Chemists have lately in a great measure agreed to have the names of all the earths to end in Al. Strontia Baryta, magnesia &c. Alumina or pure clay is so named because it is generally procured by the decomposition of Alum, which is a triple salt, having alumina for its basis.

Clay is universally diffused. It is found among the oldest formations, being a component part of Gneiss & Par which contributes to the ~~for~~ composition of the granite which is the lowest stratum. Clay is found in all parts & indeed in almost every formation: principally in those which are disposed in laminae or chertous as they are termed by geologists. In fact wherever a deposit or a formation or a mountain puts on a laminated appearance - there is good reason to believe that it is owing to the peculiar form of the crystals of argillaceous earth.



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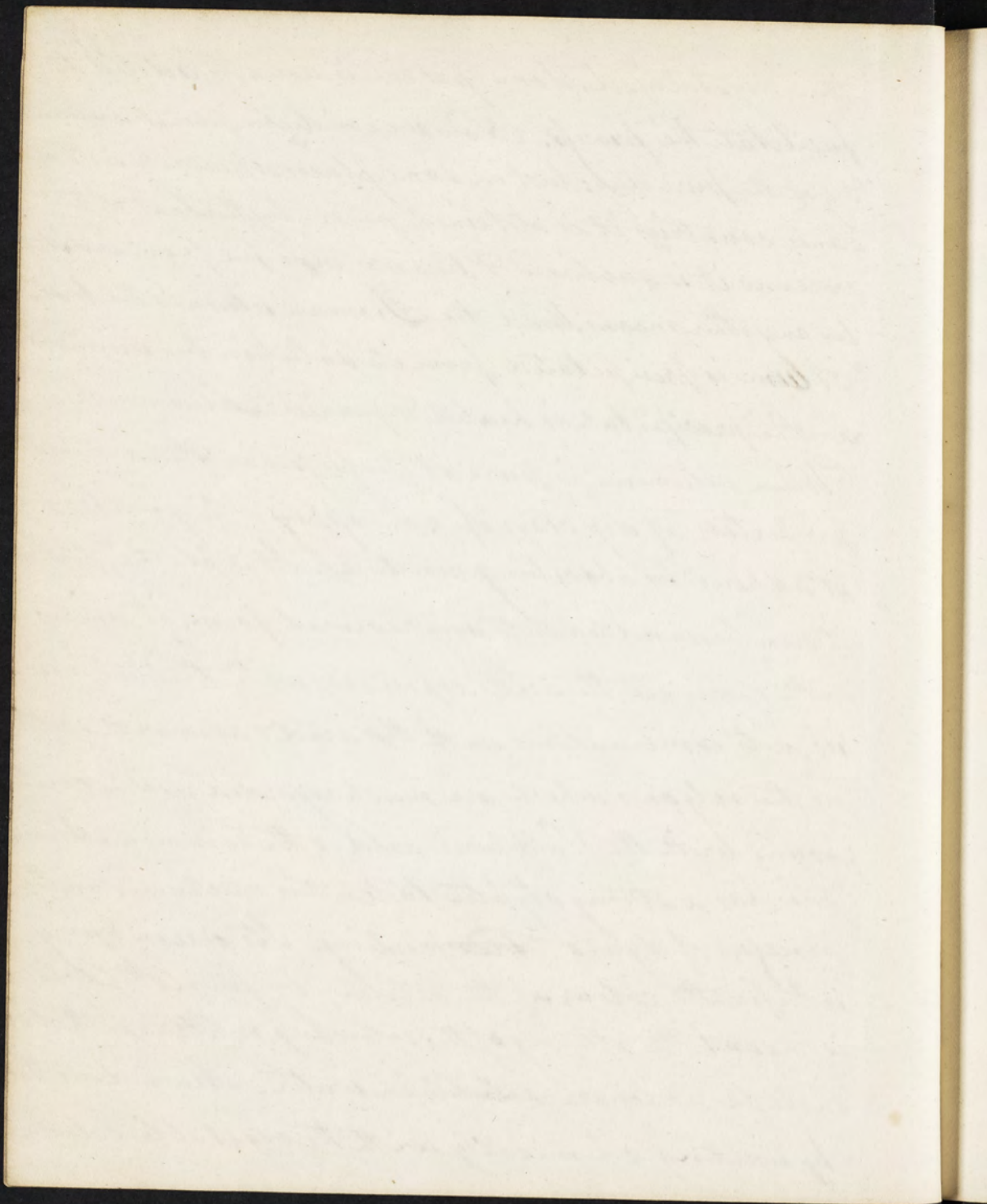
We do not get it pure. The purest kind is that used in
the Potteries. Pure clay is not found in the old forma-
-tions but is found in the later or secondary ones. To
discover whether it contains silica rub it on the teeth, the
least portion of flint will be manifest. For chemical pur-
poses it is procured pure by decomposing Alum. This
salt is made out of the chistoes or laminated earths which
contain iron pyrites. When iron pyrites consisting of
equal parts of sulphur & iron is exposed to the atmos-
-phere - it is decomposed partly by oxygen partly by
heat & also by water. The sulphur forms sulphuric
acid - this unites with the iron forming the sulphate
of iron or green vitriol. It is in this way that all the
green vitriol from long ^{is} made - but this pyri-
-tes is more or less present in all argillaceous earth, especi-
-ally over coal mines - in these cases the acid formed by
the union of the sulphur & the oxygen of the air instead
of uniting with the iron - combines with the argill
in this way alum beds are formed. The substance
thus procured is ground - is then washed & filtered - it is



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then crystallized. Some pot ash is usually added to facilitate this process. Now we can decompose this alum & get the pure clay: but in some places especially in Volcanic countries it is obtained purer - by the heat of the volcano it is sublimed & becomes more free from iron than by any other means, hence the Roman alum is the best. Alum is precipitated from its solution by ammoniac - the precipitate is heated & furnishes alumine.

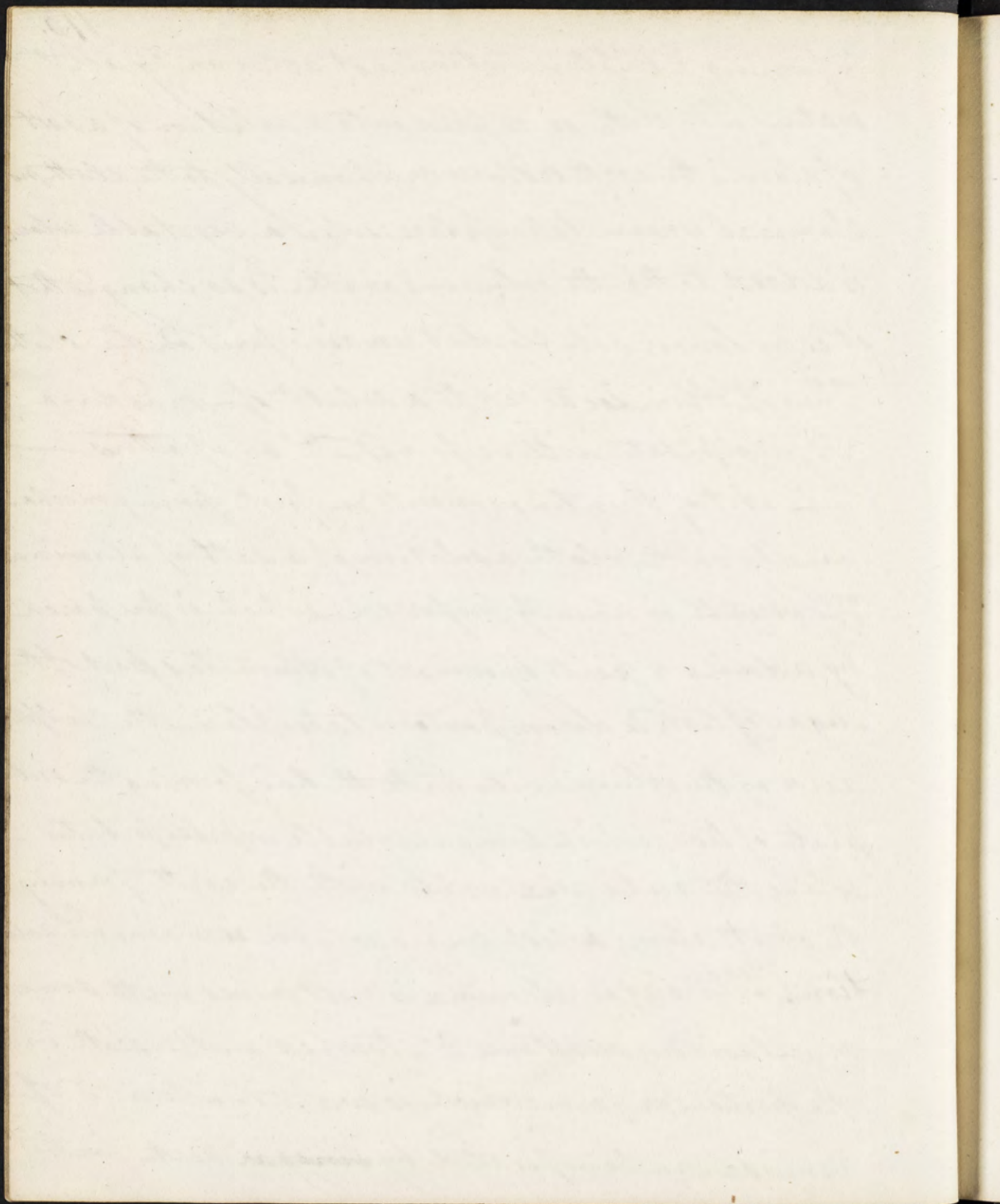
When alumina is pure it possesses all the sensible properties of dry clay: if you apply it to your tongue it adheres - by absorbing moisture. It is plastic, that is it can be moulded into any required form, it unites with nearly all the acids especially with the Sulphuric, - its combinations with this acid & also with acetic are the only ones which are much regarded. The compound with the Sulphuric acid is the common Alum. This has a strong styptic taste - & is much used in the processes of dying & ~~the~~ printing. Its use in dying is to fix the colour of the article - by fixing the colour is meant - the altering of the colouring matter so that it shall be no longer soluble in water. Alum does this by uniting chemically with the vegetable colour,



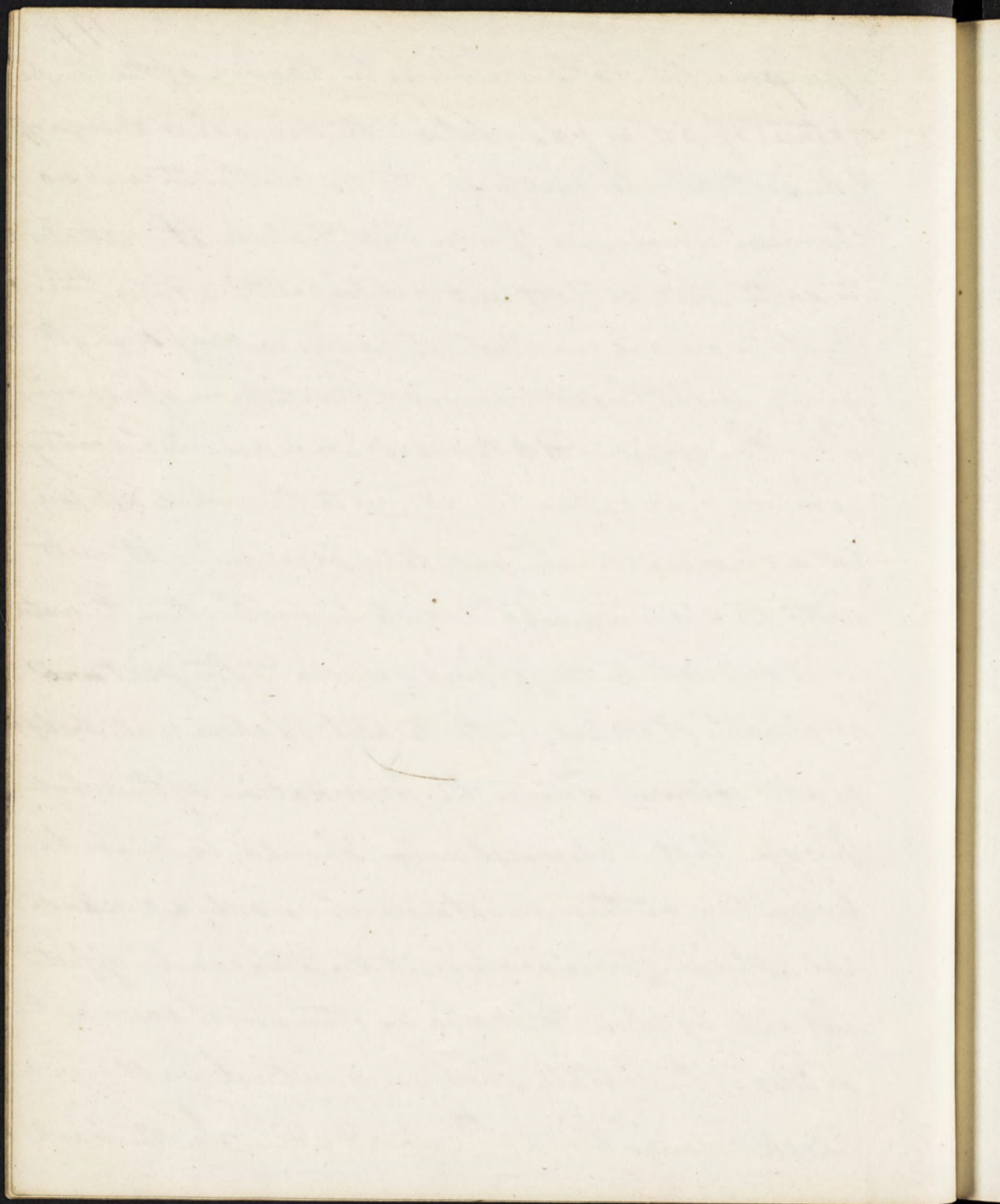
forming a triple substance not acted on by air & water. The cloth is dipped into a solution of a salt of alum - the earth adheres mechanically to the cloth, no chemical union takes place when a vegetable colour is added to this the colouring matter is so changed that it is no longer soluble - but remains fixed on the cloth.

Thus if alum be added to a solution of madder - a red precipitate will be formed - & so of others -

The art of Printing consists in first - fixing mechanically on the cloth a solution of a salt of alumina. The acetate is usually preferred - which is prepared by adding 2 parts by weight of Alum to 1 part of the sugar of lead. A decomposition takes place - the Sulphuric acid of the Alum unites with the lead forming the sulphate of lead - which being insoluble is precipitated - while the acetic acid unites with the earth, forming the Acetate of alumina: which being soluble remains in solution. This acetate of alumina is next mixed with some mucilaginous substance & stamped on the cloth in the particular form which is wanted - The acid of vinegar can be separated by ~~vinegar~~ heat - for this



Suppose the cloths are hung in a room of the tempe-
 rature of 80° or 90° by which the vinegar is driven off
 & the earth remains adhering to the cloths. There is no
 chemical union, for if you beat & shake the articles
 the earth will be beat out & dissipated? After this
 the cloths are run thro' saw dung or sheep dung to
 give a slight tinge & to prevent the earth from spreading.
 It is then rinsed - & afterwards immersed in a watery
 solution of madder - this adheres to the whole surface
 but a chemical union only takes place where it meets
 with the alumina. & the whole be boiled - then the water
 will dissolve all the adhering madder - & the part ~~was~~
 originally stamped with the acet: of alum^{was} will be left
 of a red colour. This is the foundation of the whole
 process: that a chemical union should be made be-
 tween two or three substances where only a mechan-
 ical adhesion previously existed. This can be effected
 not only by alum - but also by other substances, as the
 oxides of the metals. Thus green vitriol will give a
 black colour - tin a red colour &c &c. In the back



Parts of the country, it is often necessary for the inhabitants to dye their own clothes. If a red colour is wanted they use ~~bark~~ madder if a yellow. Ricksby & oak barks. But any bark furnishes the best yellow. You should remember that the proper proportions are 3iiij of alum to lvi. of the bark-madder will give a red & the shades from a red to a chocolate to a dark brown may be obtained by mixtures of the madder & green vitriol.

Alum^{is} the foundation of all pottery ware from the coarse brick to the exquisite china. In this country pottery is not very good - better however in this city than anywhere else in the U. States. In the country you can meet with no pottery which will hold milk if it is a little sour - or any acid whatever it may therefore be useful to know how to convert bad earthen vessels into good ones. Some years ago wishing some pottery ware to keep cyder in - I sent for bottles as they are usually made - I put one of them into a furnace - heated it for about an hour, & when it was

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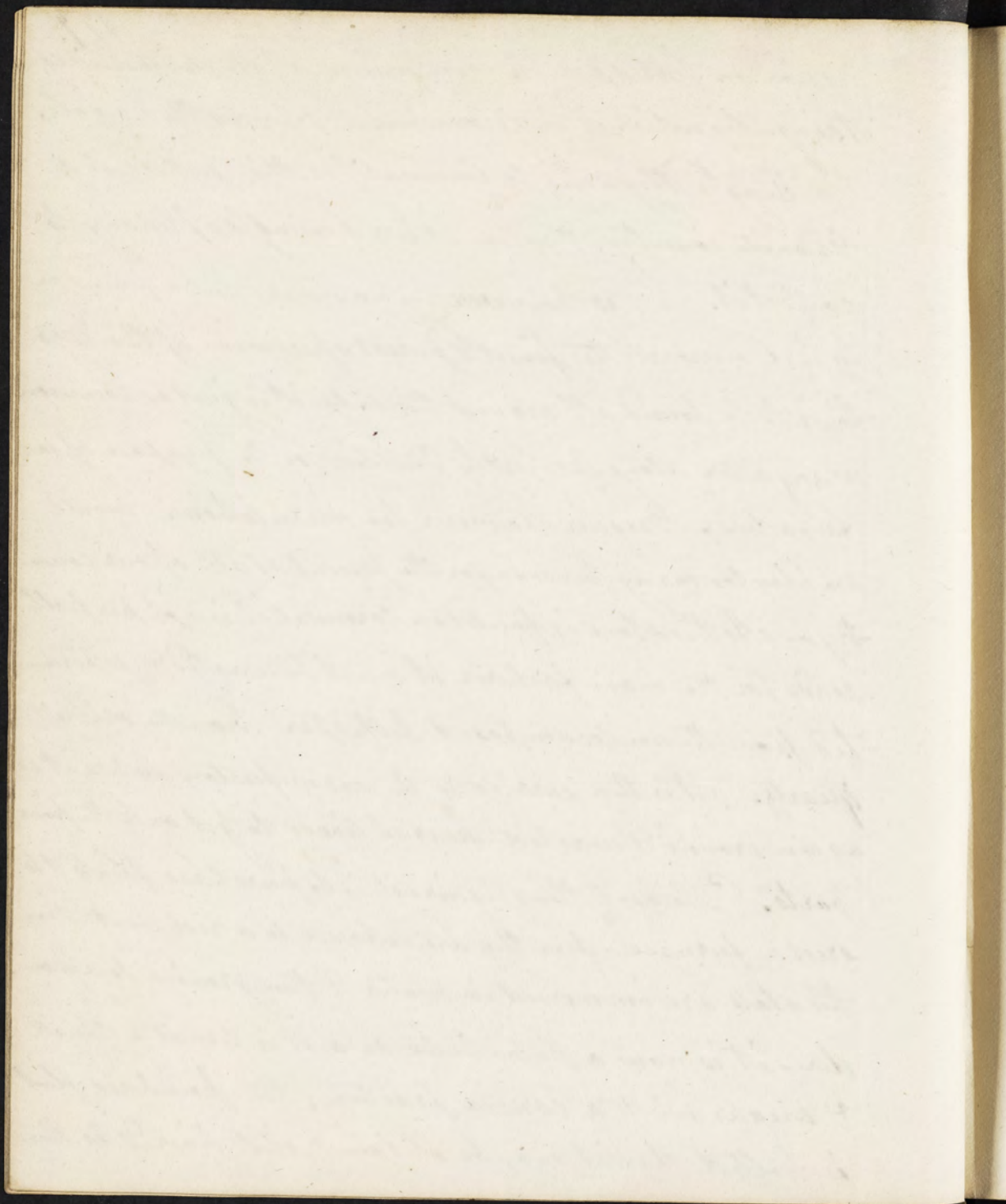
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with drawn it came out good porcelain - it would now
strike fire with steel when before a tap would have
broken it. Upon this I sent all my bottles back & paid
for having them burnt over again. In this way my
bottles would hold my cyder - & I have since kept my
mercury in them for which they are sufficiently strong
altho 40 lbs may have been in them.

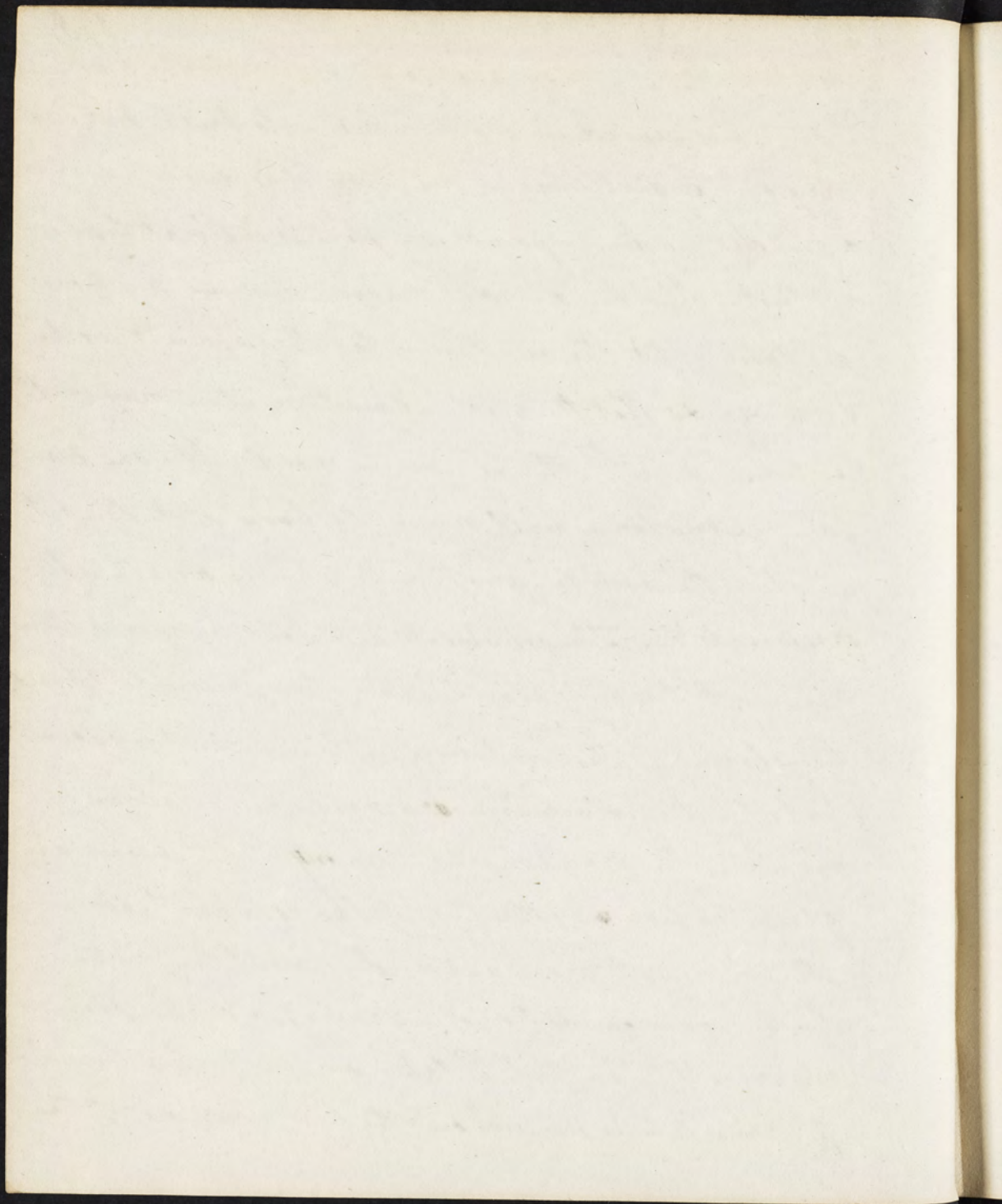
In this country China Ware is not made - one gene-
ral reason is, that wages are too high - persons here re-
ceive more profits & live much better than persons
possessing an equal capital in Eng^d. Indeed when
we consider the numerous manipulations which are
necessary, there can be no wonder why this country
will find it much cheaper to import than to manu-
facture their own China ware - In making the Li-
verpool ware the first thing required is to get the
clay which is the basis. This in Germany - France &
Eng^d is procured by analysis. The basis of the porce-
lain pottery is kaolin. This is formed from the decom-
position of feldspar - which last is a component part
of the Granite formation. The Granite is composed
of Quartz feldspar & mica. Air has a peculiar

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action on petrospar in consequence of the potassition
stains - by which it is decomposed & forms the Kaphli.
In Eng^d they send to Cornwall for this - which is a
Granite country, & where it is a business of many to
collect it. It is however by no means to be found an-
ly in Cornwall the finest & purest specimens of this Kaph-
-li is to be found all around this city - it is just as common
as any other stone perfectly adapted for the purpose of ma-
nufacture. It requires however too much labour & would
employ too many persons for the present state of our coun-
try. - As this stone is found in Cornwall it is not perfectly
ready for the manufacturer, it must be washed & ^{separa-}
-ted from the undecomposed petrospar - from the ^{mic} mist &
quartz. It is then carried to the manufactory where it is
again ground & washed - several times to get only the finer
parts. The next thing required is to purchase flints & to
erect a furnace - here they are exposed to a red heat. In
this state are immersed in water & then ground to a pow-
der - it is now a petro-silex or as it is termed a ^{cherty} chunk
& breaks with a conch fracture. The powdered flint
is bottled that it may be obtained still finer. It is then

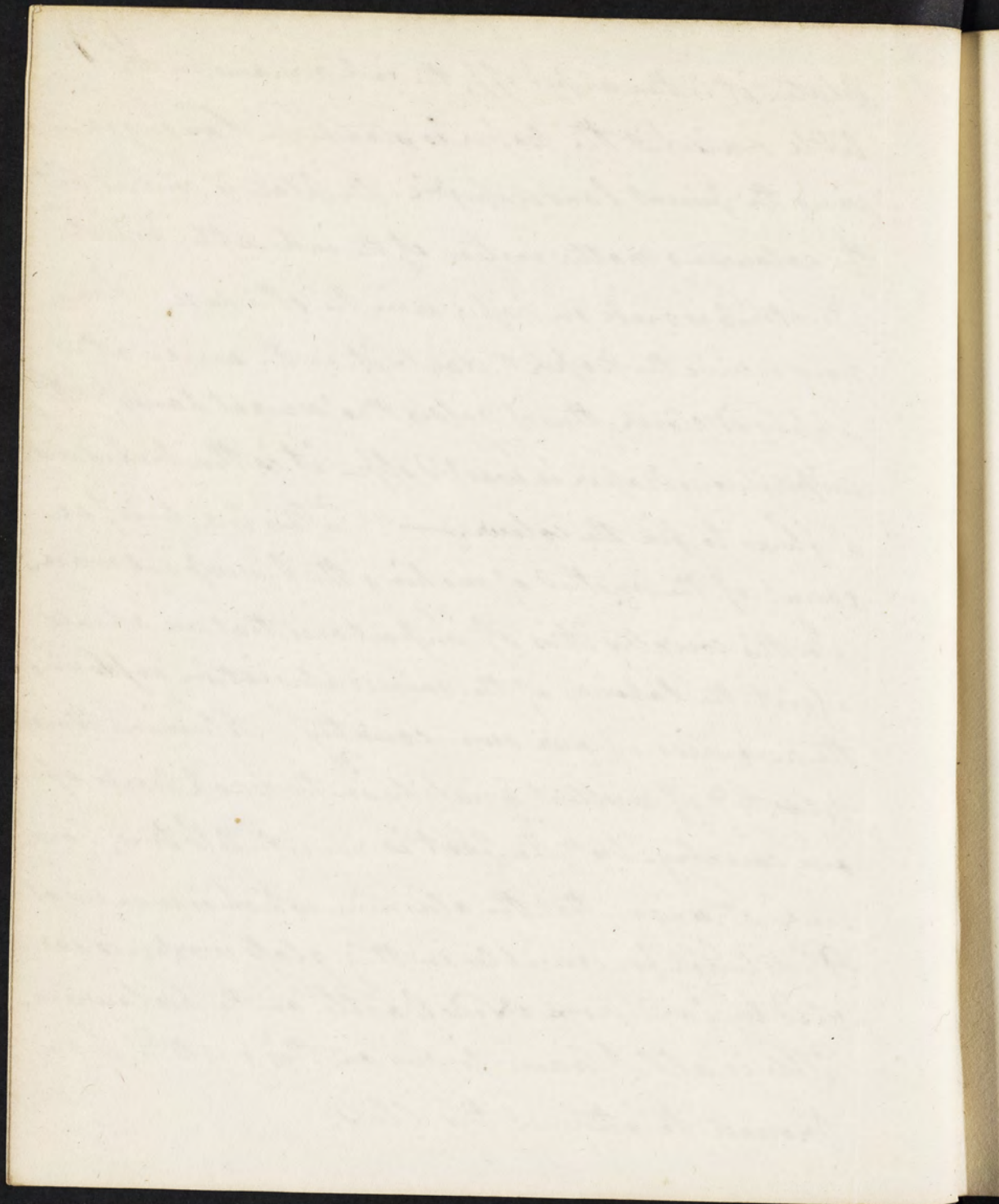


kept apart. The clay as obtained by the repeated washings
 & still suspended in water is put into brick pans to
 dry over a gentle heat - but before it is dry while it is
 a puddle, the finely powdered flint is intimately mixed
 with it - It is then divided & again mixed - portions
 are taken off & they are thrown together again & worked
 & kneaded so that the most intimate mixture may be ef-
 fected. The Potter is now to mould it - one per-
 son for instance will mould the body of the teapot,
 another the handle - another the Spout - another the
 ornaments &c. The ornaments are made by means of
 moulds. It is then placed in an open crucible & burnt.
 The glazing is then imbibed - after which it is again
 baked - the colour is now added - red is given by
 means of the crocus martis - most of the colours are
 given by lead. After this, if Landscapes, heads, or
 other ornaments are wanted they must be printed -
 In the common method of engraving - a copper plate is
 engraved & the impress is taken on fine paper - here the
 printer's ink is smeared over the whole surface of the



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plate - it is then wiped off, the ink remains in the
little crevices - & the paper is stamped - So engraving
the present Landscapes &c. - the plate is covered with
the colouring matter instead of the ink - after which
the stamp is made on paper as in the other case. Some
now receive the paper & dab it on the ware - others
apply it closer - then it passes thro' several hands & the
superfluous paper is washed off - it is then baked with
a flux to fix the colour. - This is a brief ac-
count of the method of making the Liverpool ware.
In this country it is of importance that we should
assist the Labour of the miner & geologist in exploring
the resources of our own country - Alumina is very
plenty & of excellent quality in the back parts of
our country - but the fact is nevertheless true, how-
ever strange - that the alumina which is wanted at
Pittsburgh for crucibles in their glass works - is car-
ried by land from New Castle on the Delaware.
This is all I have to say on this earth & I now
proceed to others of this class.



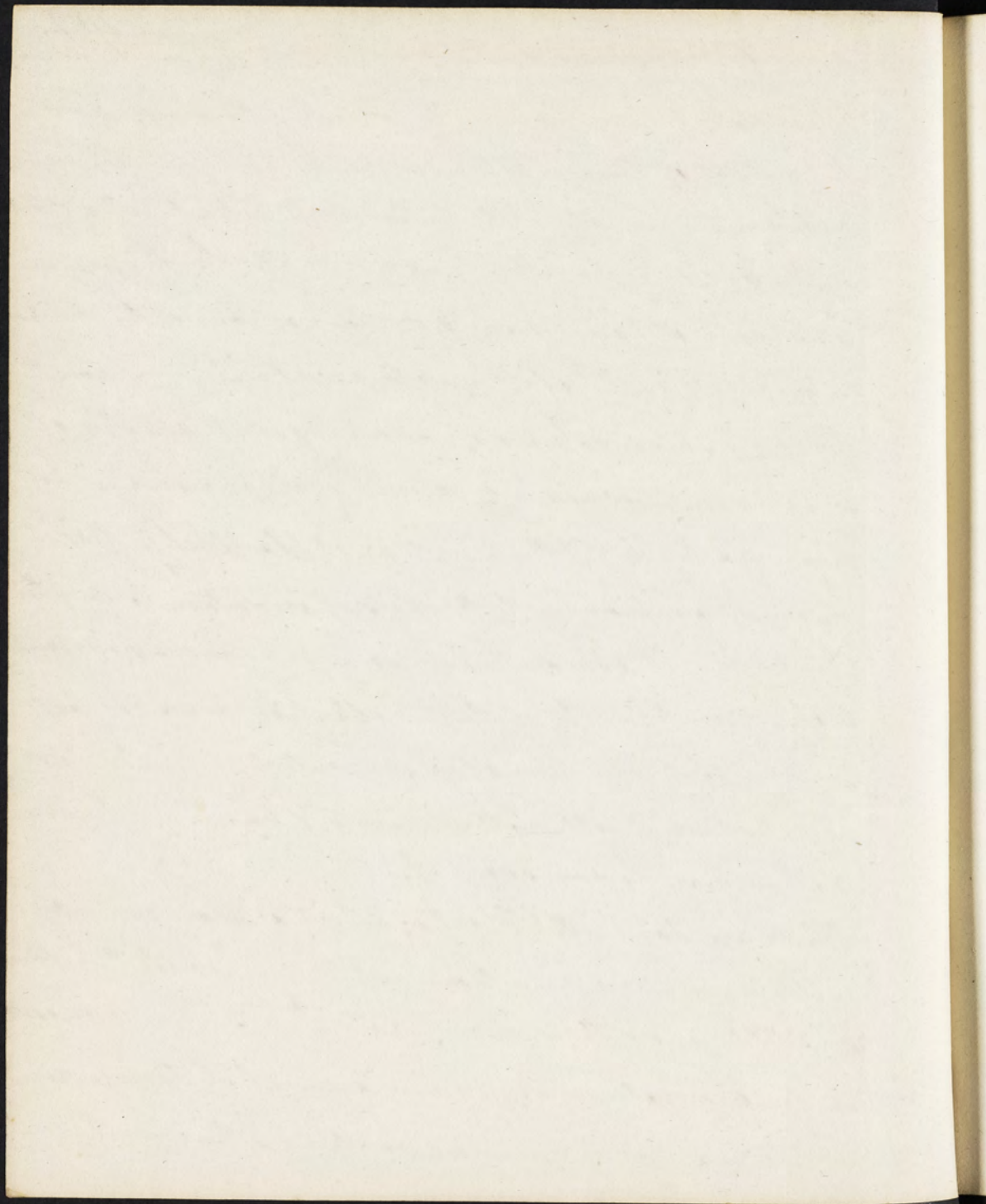
Silica, Siliceo is an earth which is very common
 it is found in every formation & almost in every part
 of the stratum. It can be procured pure from flint-
 transparent pebble &c - it is procured nearly pure
 from the common green flints. It will not unite with
 any of the acids unless very indirectly, it combines
 with all the alkalis, by which the properties of each
 are entirely destroyed & a new substance glass is the
 result. Glass is obtained from fusing flint with
 Potash or Soda - which of these is preferable is unde-
 termined. A cheap method of furnishing soda has lately
 been adopted in Germany. Glauber's salt is the refuse
 of several processes in the manufactures - & can therefore
 be obtained very cheap in Europe - When Potash &
 silica are melted together a glass is formed - but it is supposed
 that the best glass is made with soda - this however is
 not determined - when soda is wanted - a quantity
 of the Sulphate - or Glauber's salt is added to the sili-
 ceous potash, the sulphuric acid unites with the
 potash - & the soda & silica combine - When glass

is wanted finer a quantity of lead is used. I 181.
have frequently fused barometer tubes with equal parts
of pot ash & the common salt of tartar & of lamp-black
from 3j of these pieces of glass finely ground I have often
obtained 3i of metallic lead. The charcoal unites in this
case with the oxygen of the glass & is converted into car-
bonic acid gas & flies off - & the lead separated from its
oxygen is therefore reduced. — Silica is soluble in
3 or 4 times its weight of pot ash; the pot ash must be
in a superabundance. If I add an acid so as to sa-
turate the pot ash, the silica will be precipitated in the
form of a jelly. If exposed to a violent heat silica
may be obtained pure from glass in the following way.
Take a certain quantity - say 3i of fine glass - melt
3ss with salt of tartar & lamp-black - in the first
place you will get the lead - to ascertain the quantity
of red lead that was present - add 14 parts to the metal
obtained, allowing for water. You then want to know
the quantity of pot ash & flint: to discover this add to
the glass 4 times its weight of salt of tartar well dried,
precipitate the silica by an acid - heat the precipitate

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so as to dissipate the water & you will have the silica.
 You now have obtained the red lead & the silica - now
 the weight of the potash will be equal to the difference
 between the weight of the litharge & the silica together & that
 of the glass submitted to experiment. In this way si-
 lica may be obtained pure & the proportions of the several
 ingredients of the glass may be ascertained. From the
 property silica possesses of combining with alkalis, of
~~uniting with~~ ^{withdrawing} oxygen & of expelling carbonic acid - it has
 been conjectured & I think with great plausibility - that it
 belongs more properly to the class of acids than to any other.
 The basis of it appears to be oxygen - as by adding oxygen
 to it, it unites better with the alkalis. Hence red lead
 is added to it when fine glass is wanted. Silica is of
 essential use in all pottery as is well known & I have
 nothing more to say about it.

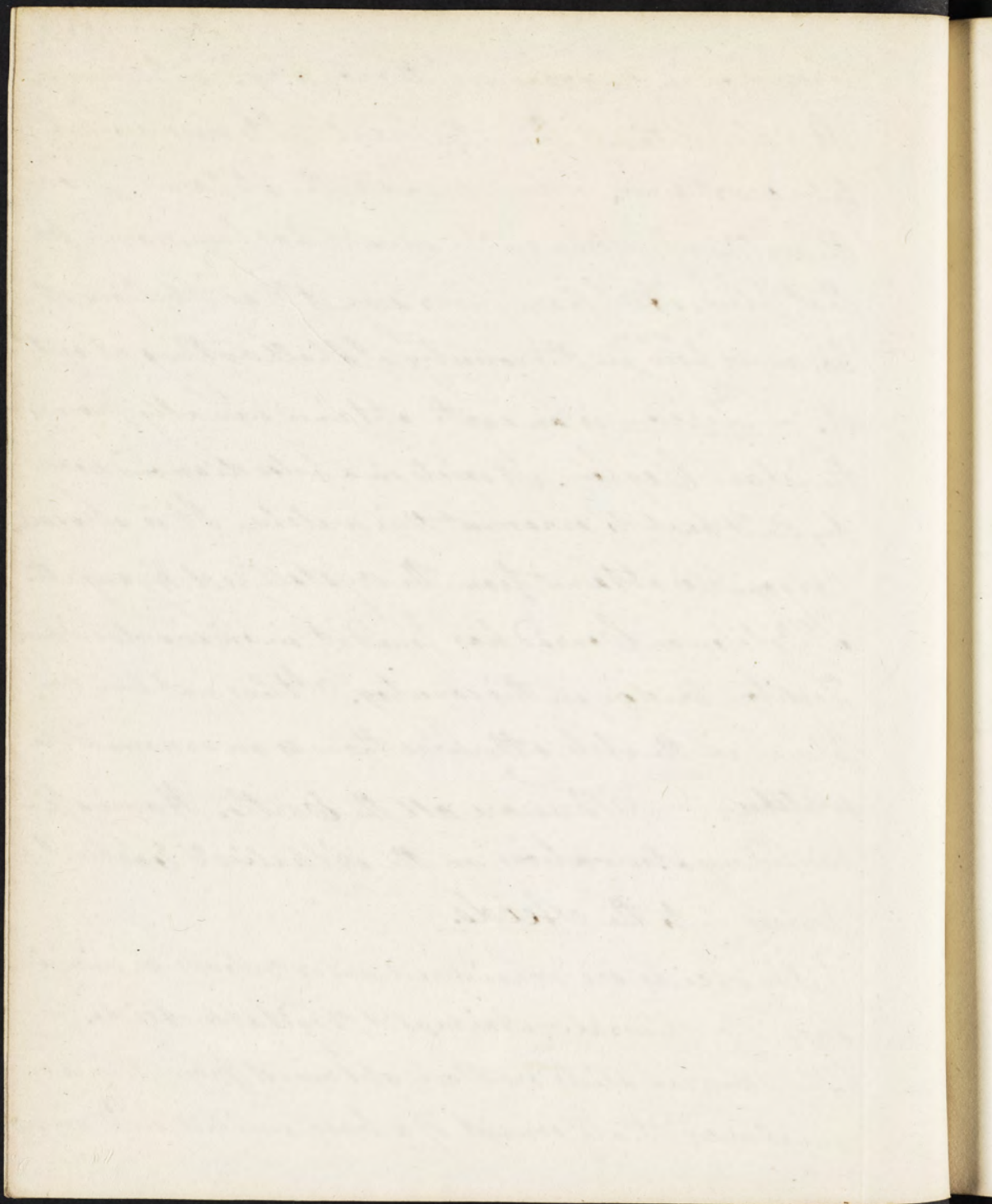
There are some other Earths; which are however very
 little known & very seldom employed - I shall therefore
 do little more than enumerate them. There is one earth
 in the Emerald - which having a sweetish taste is named
Glucina. It is found in analysing the emerald, which



is common in the granite of this country & in Germany. It is also obtained from the beryl. Its uses are yet to be ascertained. There is an earth obtained from the valley of Githria in Sweden & has been named from that place. As I have never ^{seen} it - & as I believe it has never been ^{seen} in this country I shall not write about it. - Lirion is an earth obtained usually from the island Ceylon. It exists in a pale diamond used by the French to ornament their watches. It is also called Jargon - & is obtained from the crystallized Hyacinth. Mr. Solomon Courad has found it in an insulated ^{part} near Tredition bridge in this country. It has not been employed in the arts otherwise than as an ornament to watches. These are all the Earths. Having finished my observations on the Alkalies & Earths I proceed to the Acids.

The Acids are considered under 3 heads or divisions. The Mineral - Animal & Vegetable Acids.

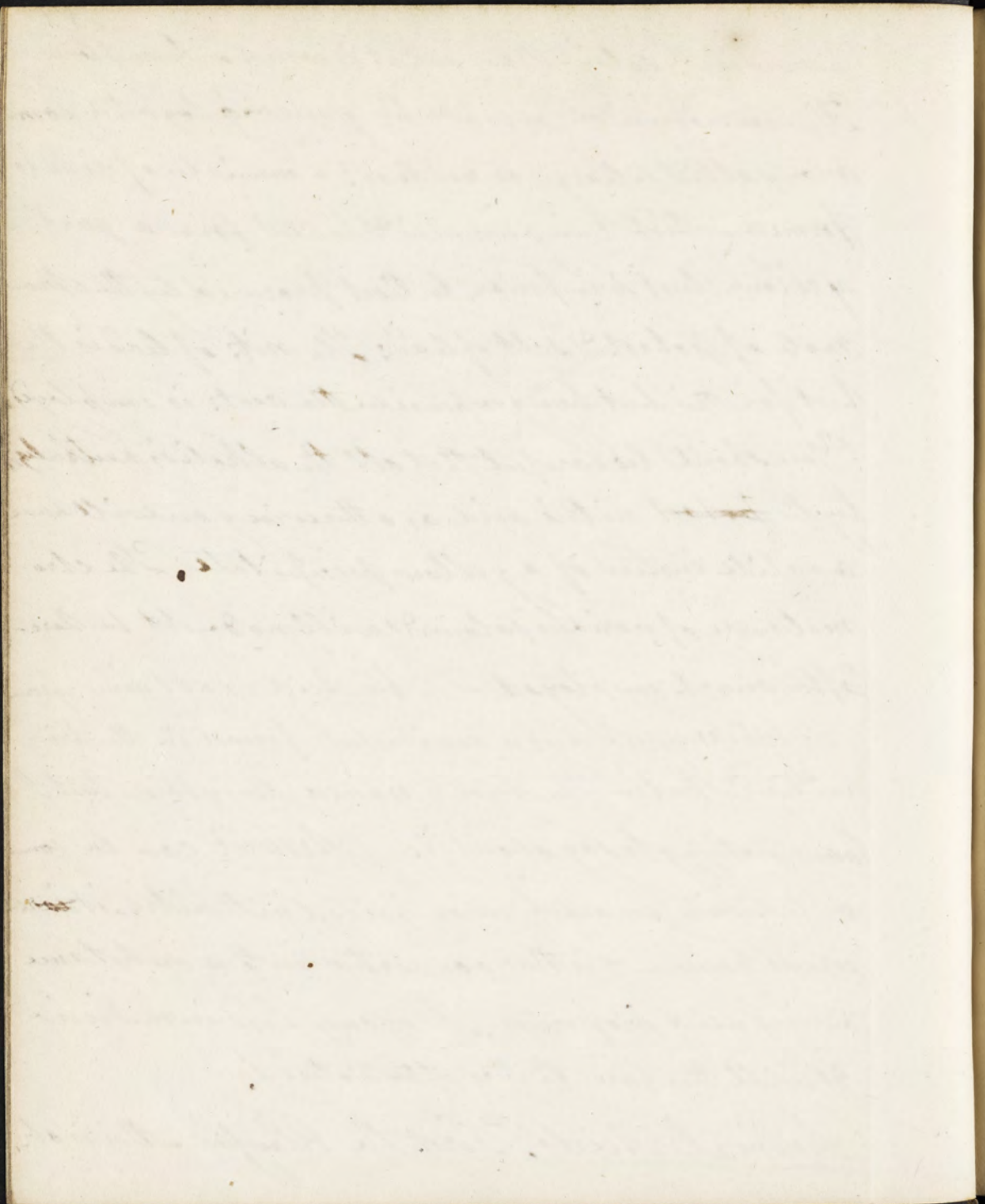
The Mineral acids are those obtained from Mineral substances - & all consist of a base united with oxygen.



Of these I have already noticed the Sulphuric, the Nitric & Muriatic when treating of the gases. Of the remainder the first to be noticed, is an acid forming a combination with iron which is very common in this country, especially about Baltimore: this is the Chromate of iron, from which is obtained the Chromic acid. It is always found in a state of combination - in which it exists in the form of an oxide. To obtain the acid the chromate is ground with $\frac{1}{2}$ its weight of nitre & then exposed for an hour to a violent heat. The acid of the nitre is decomposed & yields its oxygen to the oxide of Chrome which thus becomes acidified. It then unites with the pot ash of the nitre forming the chromate of pot ash; there is however always present some nitre undecomposed & some pot ash uncombined. To obtain it pure you must add oxalic acid to saturate the pot ash. You will then have a Nitre & Chromate of Pot ash: then by repeated crystallization the acid may be obtained. In going thro' the regular rout of analysis - it has been discovered that a yellow ~~liquid~~ precipitate is formed by adding the Chromic acid to lead - which is a brighter & more

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permanent-colour than what is commonly employed.
 The common yellow is made by grinding together com-
 mon salt & litharge or red lead: a muriate of lead is
 formed which being washed & heated forms a good
 yellow - but is inferior to that procured by the chro-
 mate of potash & salt of lead: The nit. of lead is the
 best for this but being expensive the acct. is employed.
 You should be careful that all the alkali is neutralized
 by the ~~potash~~ nitric acid as otherwise you will have
 a white instead of a yellow precipitate. The chro-
 mates are of various colours & will no doubt be here-
 after much employed - Iron Acid is obtained from
 Molybdena which is a semimetal found in the pri-
 mitive strata - The Acid is named Molybdic - but I
 have nothing to say about it. Arsenic can be con-
 verted into an acid, when boiled with nitre ^{acid} - it ~~receives~~
 receives oxygen & is thus converted into a substance
 having acid properties. It is only used in medicine
 & will therefore be hereafter noticed.
Animal Acids. First the Prussic - this is ob-



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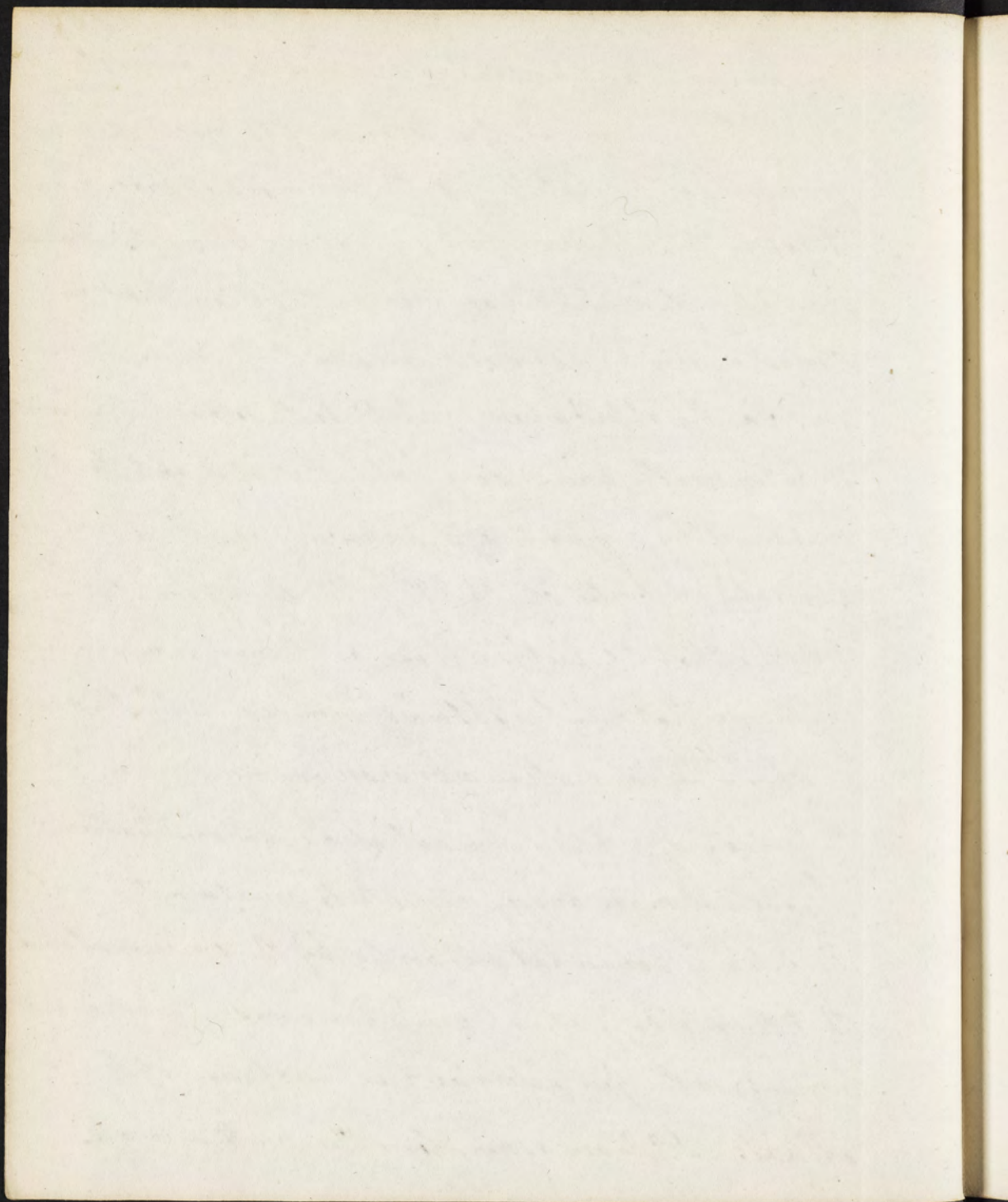
tained from the prussian blue. This is made by calcining the horns-hoofs &c of animals with $\frac{1}{2}$ their weight of Potash; this is then lixiviated - & a precipitate is obtained by adding to it the Sulphate of iron, this is the prussian blue. It is improved very much by adding to it muriatic acid. The acid is obtained by boiling a solution of the prussian blue ~~oxide~~ precipitate ^{may be obtained from the German Cyanogen} a gas will be produced called Cyanide the characteristic of which is that it burns with a blue flame - the acid may be obtained by crystallization -

It is of no use except in forming the prussian blue which withstands all acids - but is however soluble in ~~water~~ the alkalies. It will not therefore answer as a dye - as soap would speedily destroy it. The best blue dye is indigo - as this resists alkalies as well as acids nothing will attack it - it is the best & most lasting.

There are many other animal acids - of all of which Hydrogen & Nitrogen form the basis. You can obtain acids from the distillation of all insects - but they are not of

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appropriated to any particular use; except in one instance,
 which I have heard of. In Germany they procure a very
 good vinegar by distilling ants - the mode of procuring
 it however will prevent its general employment. I ought
 to mention that I have good reason to believe that the
 stings of wasps & bees is owing to the presence of an
 acid; as the application of chalk to the wound very speed-
 ily removes the pain - so quickly that it is only to be
 explained by supposing the presence of an acid which is
 neutralized by the chalk. Whether the explanation is
 correct or not, the fact is certain, as I know from my own
 experience that relief is obtained immediately by the above
 article. The idea afterwards arose in my mind, whether
 the poison of reptiles was not also of an acid nature;
 I have not made any experiments to ascertain this but
 the idea is somewhat supported by the circumstance
 that the most effectual remedy in cases of poisonous
 wounds is the free external & internal use of the Vol:
 Alkal: Dr Ramsay employed this with success.

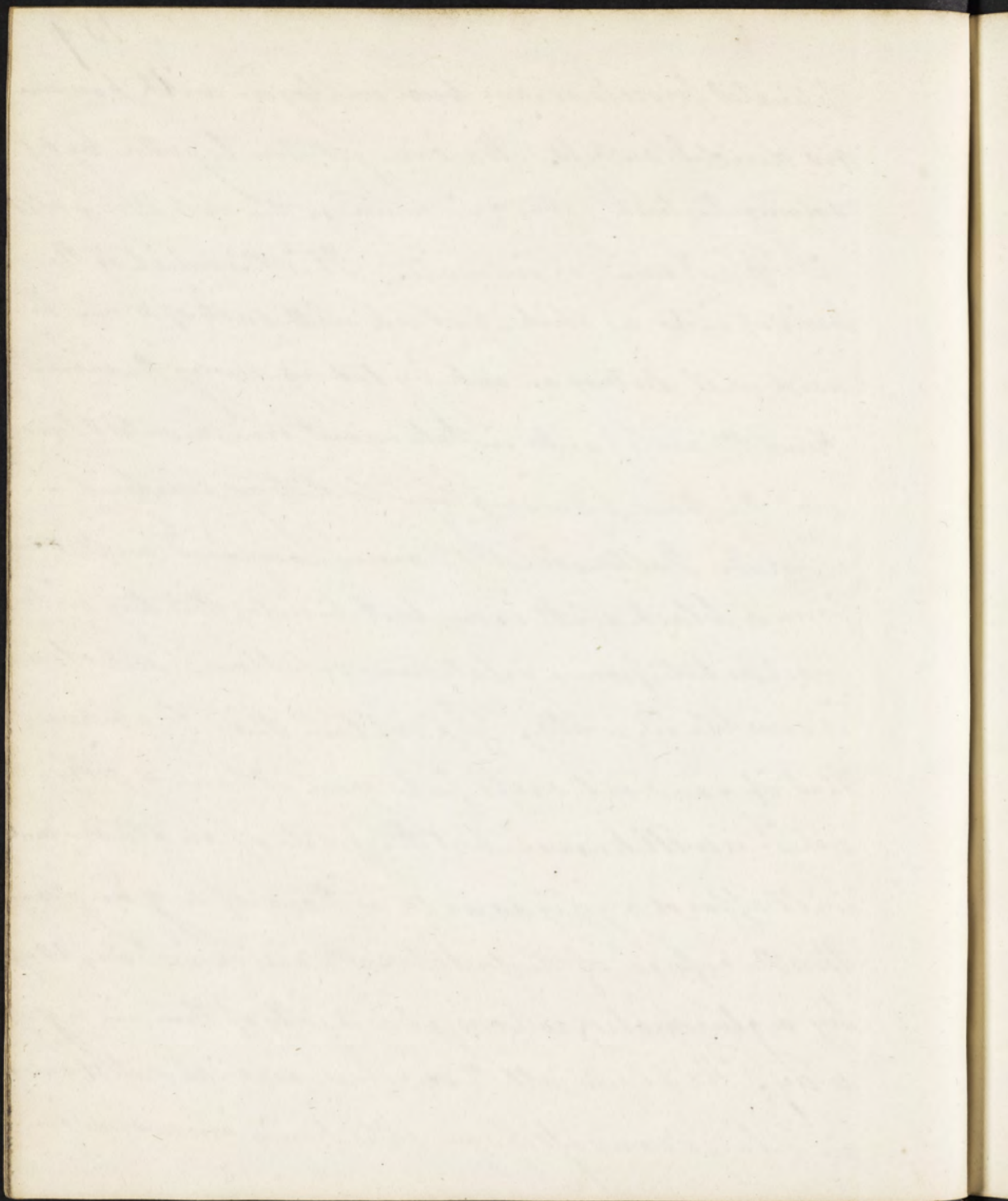


The Vegetable Acids. There is an acid procured from Galls & hence termed the Gallic Acid. Gall nuts are a vegetable excrescence, the midrib of an insect which pierces the bark of the tree. They contain the principle which is known peculiarly & characteristically by the sense of astringency imparted to the tongue. This is also found in the different parts of the oak but is particularly resident in the Gall nut - & in the terra japonica - or extract of Catechu. This astringent principle is a compound of two substances, one strikes a black with the sulphate of iron - & the other which is generally but not always combined with it is called tannin from being used in the process of tanning leather - & does not afford a black precipitate with green vitriol. It was formerly supposed that the astringent principle was homogeneous - but it is now ascertained that the part which strikes a black colour is different from the part which makes leather. To separate these many very ingenious Chem.

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elaborated processes have been employed - with however
no decided success. We can get them together by dis-
solving the terra japon: in water or the oleo picro gallic
in Sp^t of wine or in water. It is this which is the
basis of inks, as striking black with salts of iron. Any
acid will destroy an ink by taking away the iron.

Hence the use of acids in taking out iron moulds & hence
also they have been employed to destroy writing -
Thus the Gallic acid & Tannin combined will de-
form a black with iron, but besides this they will
precipitate from a gelatinous solution a substance
insoluble in water. To explain this - I observe
that if you boil calf's feet - you obtain a jelly -
which is well known - but the parts of an old animal
will afford a jelly as well as those of a young one
thus the refuse of the butcher & carrier is bought up
by a glue maker who makes a jelly of them in a gross
way. He places all these refuse animal substances
in a large canvas bag - after being immersed in

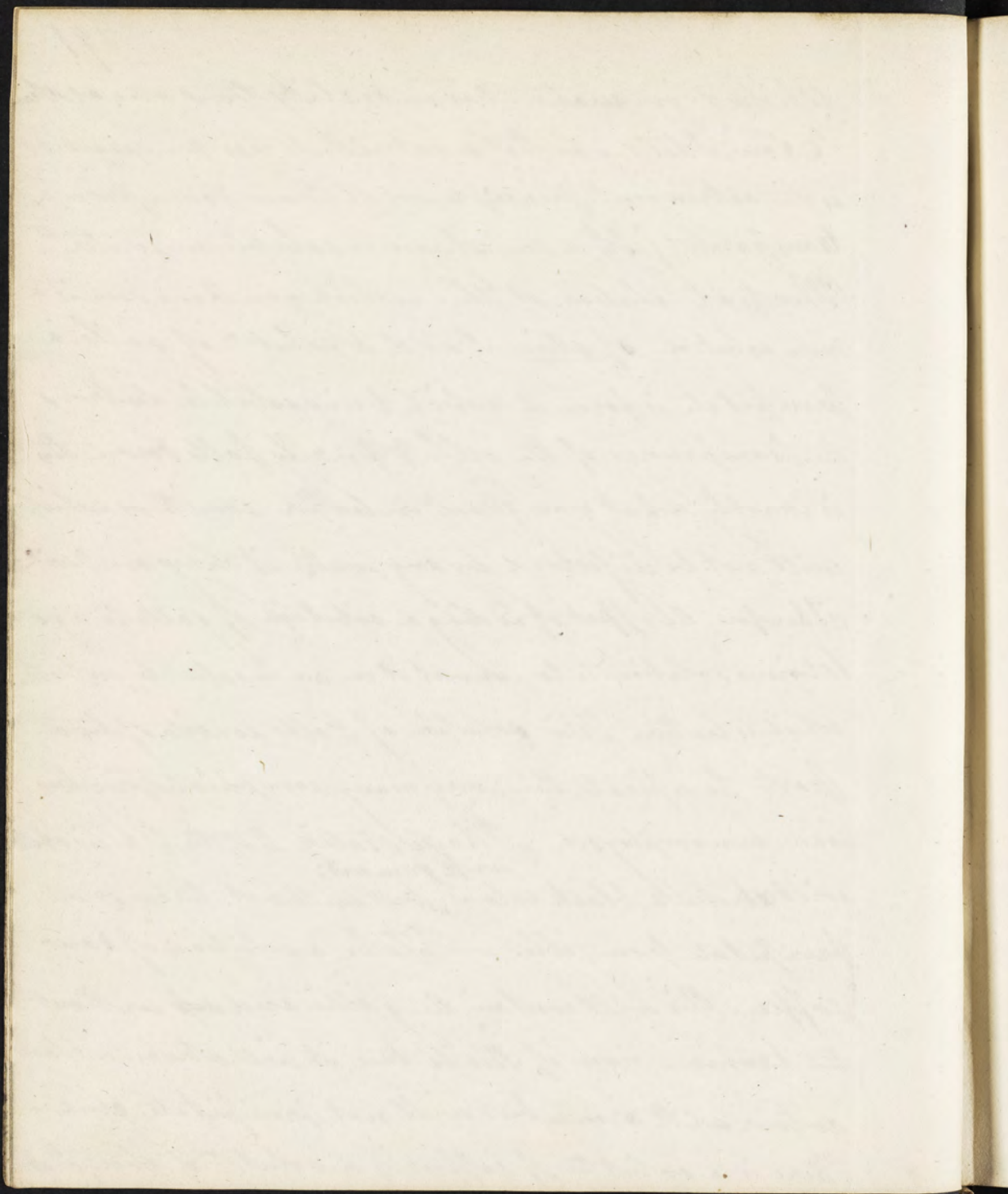


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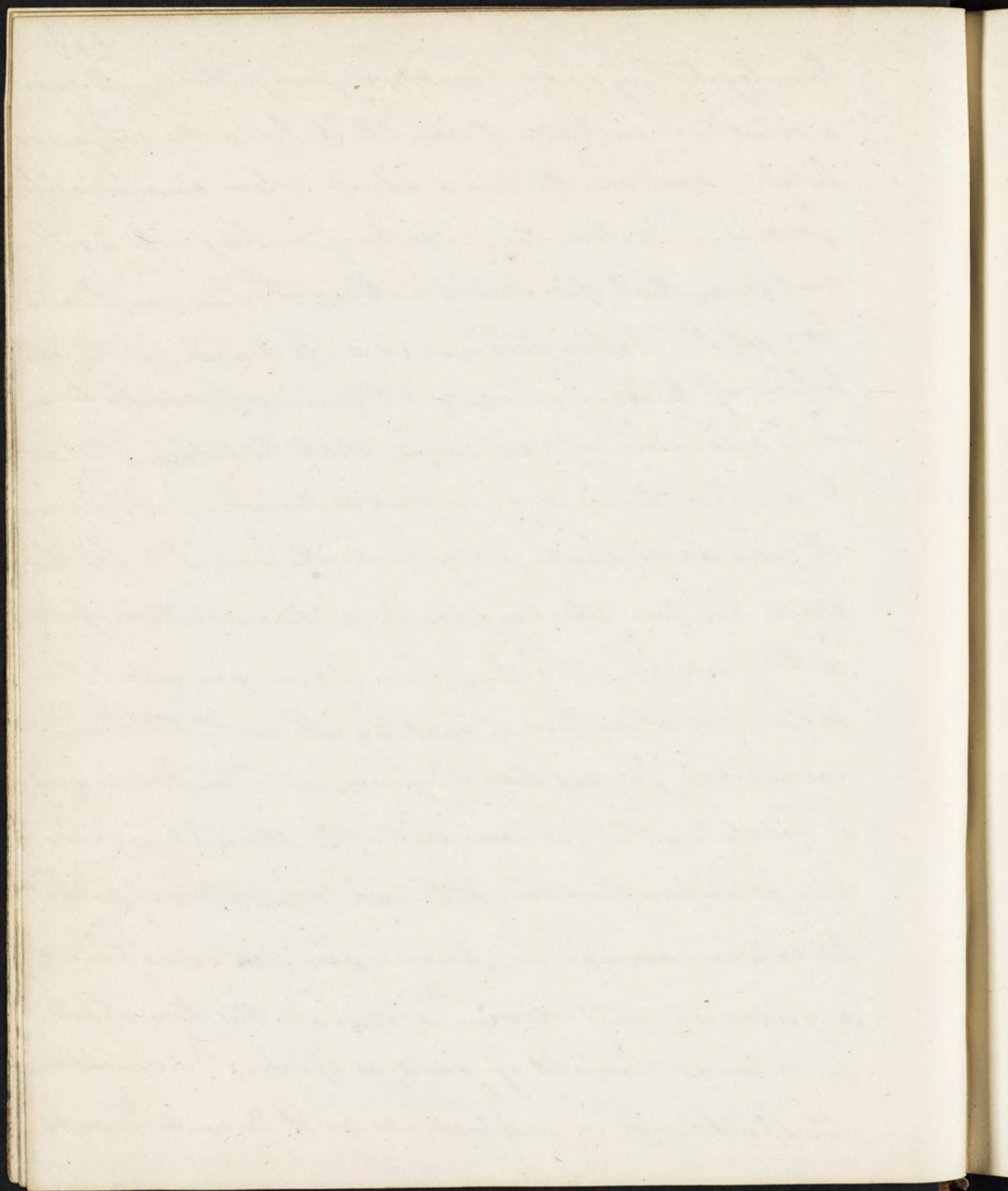
lime water to destroy the hair - the bag thus filled is
suspended by an iron chain in an iron boiler filled
with water - It is now boiled, till all the soluble
parts are dissolved which process is facilitated by oc-
casionaly pressing the bag by machinery. A jelly is
thus formed - which is strained - filtered - boiled down
to the consistence of the common jelly of your table
& while warm ^{loured} into troughs 4 inches deep - & of a width
proportionate to the size of the cakes to be made -
It is then allowed to cool & become solid - after which
it is cut in proper lengths - & dried - by which process
it contracts very much. A man having a frame with
wires situated at proper distances is enable to cut a
great number at one stroke - which are dried & form
the common glue cakes. Glue therefore is nothing
more than Portable soup. The soup is made precisely
in the same way, the soluble parts of an animal are
boiled down to a jelly - ~~are~~ the necessary condiments
are added - when cool it is cut into pieces & dried.
Glue then is the same as jelly - & is merely skin

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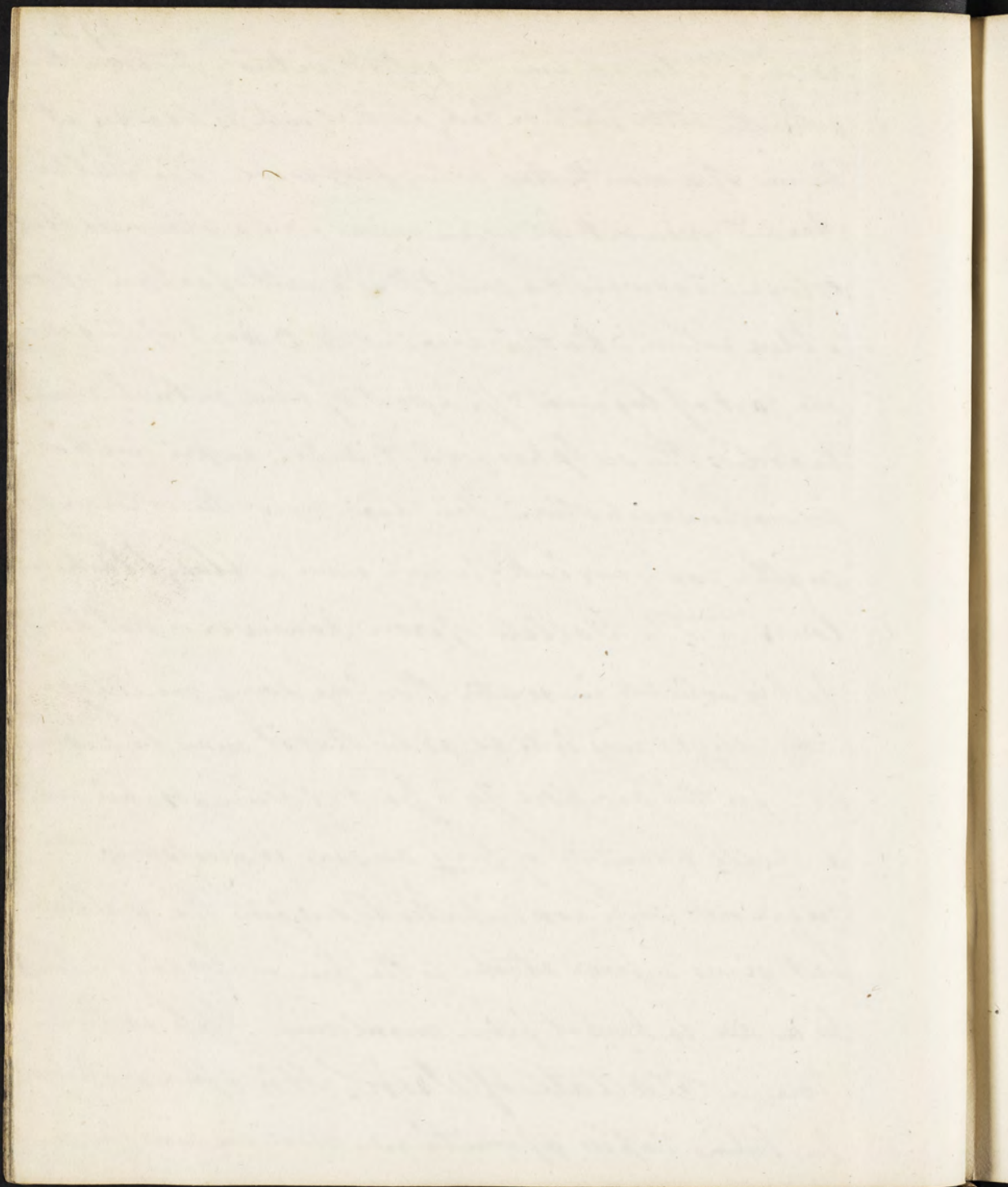
dissolved in water - & is in reality the same as skin.
 Now I told you that what hitherto has been regarded
 as the astringent principle will throw down from a
 transparent jelly, a substance insoluble in water.
 Thus the solution of glue - which you have seen is a
 mere solution of skin I add a solutⁿ of galls - a
 precipitate is formed - which being ⁱⁿ soluble destroys
 the transparency of the jelly & finally falls down - this
 is exactly what you want in leather - something which
 will not be dissolved by any water it may meet with.
 Therefore the effect of adding a solution of galls to a ge-
 latinous solution is to convert it in an insoluble substance
 which is leather. This solution of Galls consists of two
 parts - to separate them very many complicated processes
 have been employed. I have stated that the Gallie acid
 will strike a black colour ^{with green mixt:} - but will not throw down a
 precipitate from jelly. - Take a solution of raw
 coffee - this will contain the gallic acid ~~and~~ without
 the tannin - now if this be true, it will strike a black
 colour with iron - but will not precipitate glue -
 There is a solutⁿ of coffee - & a solutⁿ of glue, I add



them together, if you see there ~~is~~ no precipitate. There is
 a solution of sulphate of iron - to it I add the coffee so-
 lution - you see there is a black colour immediately
 formed. Therefore the property of making ink is differ-
 ent from that of making leather. You can there-
 fore get the Gallic acid united with tannin, in the so-
 lution of Galls - you can get the acid separately by ma-
 king a solution of raw coffee. As to the tannin I do not
 know that there is any process yet devised of obtaining
 it pure or separate from the acid. — The Gallic
 acid therefore striking black with a solution of iron
 is the basis of all ink. I will give you what I con-
 sider the best method of making ink, with the chemi-
 cal reasons for my ~~own~~ opinion. — The Gallic acid
 is volatile. The carbonic acid of the atmosphere gradu-
 ally acts upon the iron in the ink & dissolves it, so that
 the ink in common use becomes ~~so~~ after some time of
 a yellowish rusty colour. To obviate this, there should
 be 3 times the weight of galls, as of iron; & boiling wa-
 ter should not be employed - as by it the acid is wa-



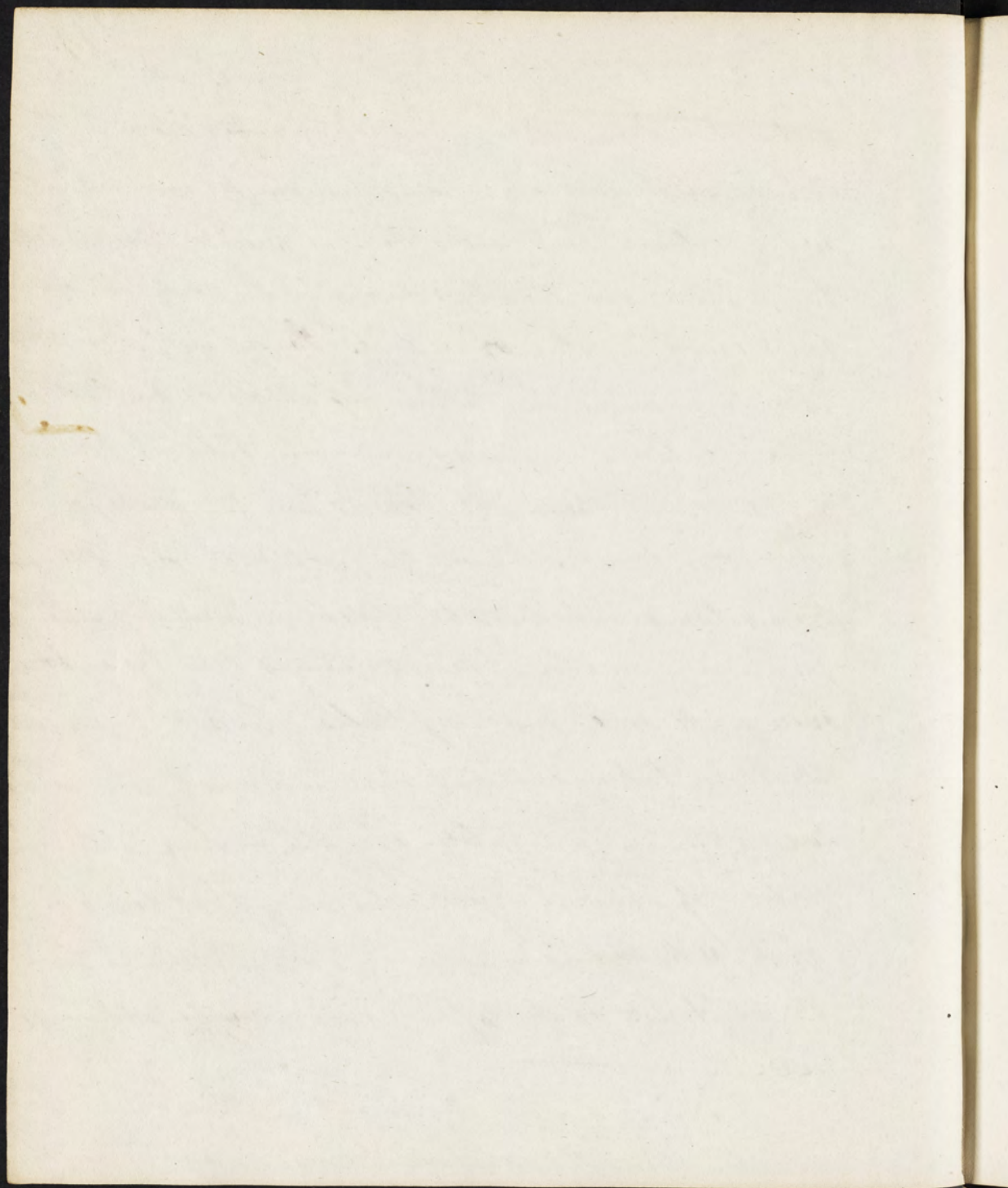
nated. The longer time the galls & vitriol continue to-
 gether the better will be Ink, so that ink is blacker at
 the end of a month than when first made. The Gallii
 Acid & green vitriol when mixed give a brownish black
 colour - logwood & a solution of a salt of copper affords
 a blue colour - On this account to 3 parts of the galls
 one part of logwood & $\frac{1}{2}$ a part of blue vitriol should
 be added: the sulphas ferri. & sulph: cupri will not
 decompose each other. You have now the colouring
 matter for your ink: which gives a blue, black co-
 lour. The Gallate of iron however is not per-
 fectly soluble in water therefore some mucilagi-
 nous subst^{ce} is to be added that it may be suspend-
 ed - for this purpose $\frac{1}{2}$ a part of Gum arabic with
 a small quantity of loaf sugar is necessary: the
 sugar not only contributes to suspend the gallate
 but gives a freer stroke to the pen - Brandy should
 be added to keep it from moulding. Ink is there-
 fore a Gallate of Iron. It is often employed
 in taking copies of writings - these are rendered much



more perfect by the addition of sugar. - All inks are destructible by acids, especially by ~~the~~ Chlorine. If it be required, that ink should remain permanent in the air & be changed by no chemical process there are but two ways of effecting this: one is by the addition of lamp black & the other of indigo. By either of these ways it will no longer be acted on by acids, or by the sun & air. ^{The} Antients employed an ink made of lamp black suspended in Glee. At Herculanum it was found that altho' the scrolls were perfectly charred yet the atramentum or ink was still visible, remain in uninjured. To recover effaced writings you brush them over with an infusion of Galls. In all paper employed for taking copies it will be useful previously to dip them in a solution of galls. - Ink is the foundation of several dyes, when diluted it forms a gray - & by adding madder in various proportions the different shades of red & gray may be obtained.

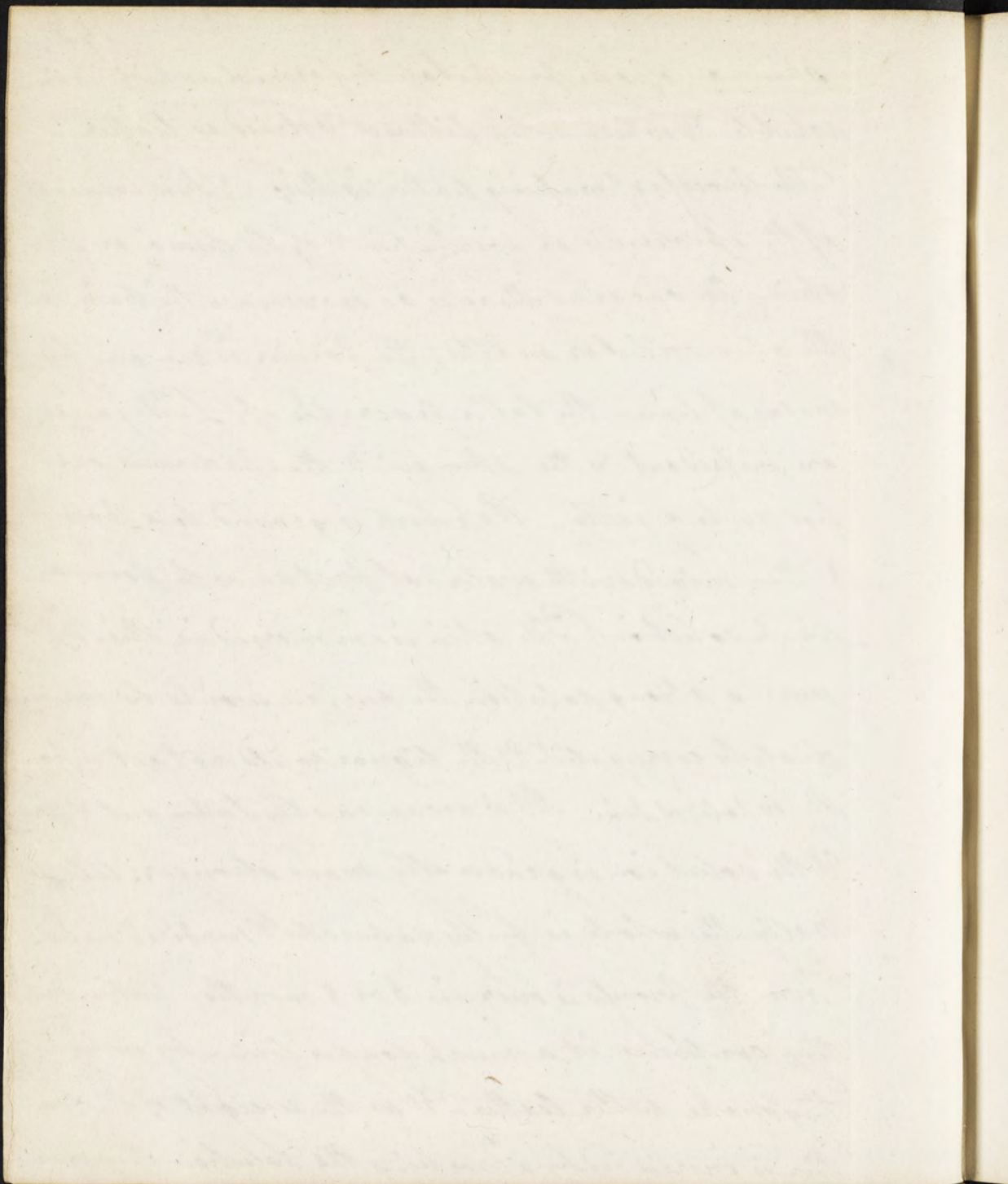
Ex. 10

Tanning is another ingredient in the solution of galls - When this solution is added to a solution of



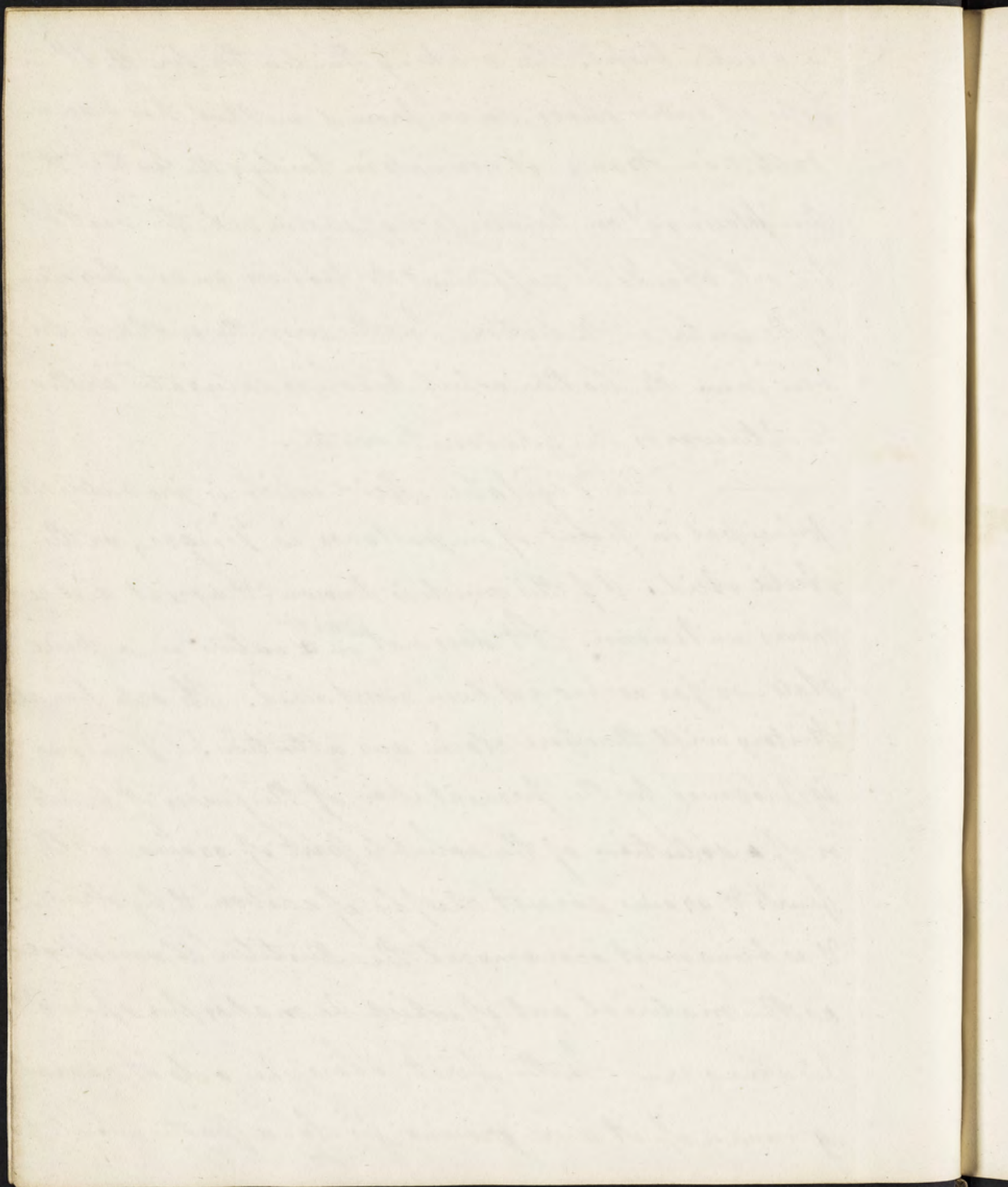
skin - an opaque precipitate is formed - which is insoluble - & which when filtered & dried is leather -

The process of making leather is this: Skin consists of the epidermis or scarf skin & of the derma or true skin - On one side there is an excrescence the hair on the other cellular matter; the former is removed by means of lime - the latter is scraped off - The juices are pressed out - & the skin with the epidermis are boiled to a jelly - Oak bark is ground to a powder & then mixed with water - at first so as to form a weak solution - The skin is immersed in this - if it were a strong solution, the surface would be immediately corrugated - & the liquor could not act upon the whole skin. It is occasionally taken out & pressed & the solution is gradually made stronger: till finally the whole is fully saturated & rendered solid. Here the process is over in 6 or 8 months - but in Eng they continue it a much longer time - by which they make better leather - & as the weight of the leather is increased by absorbing the solution they make

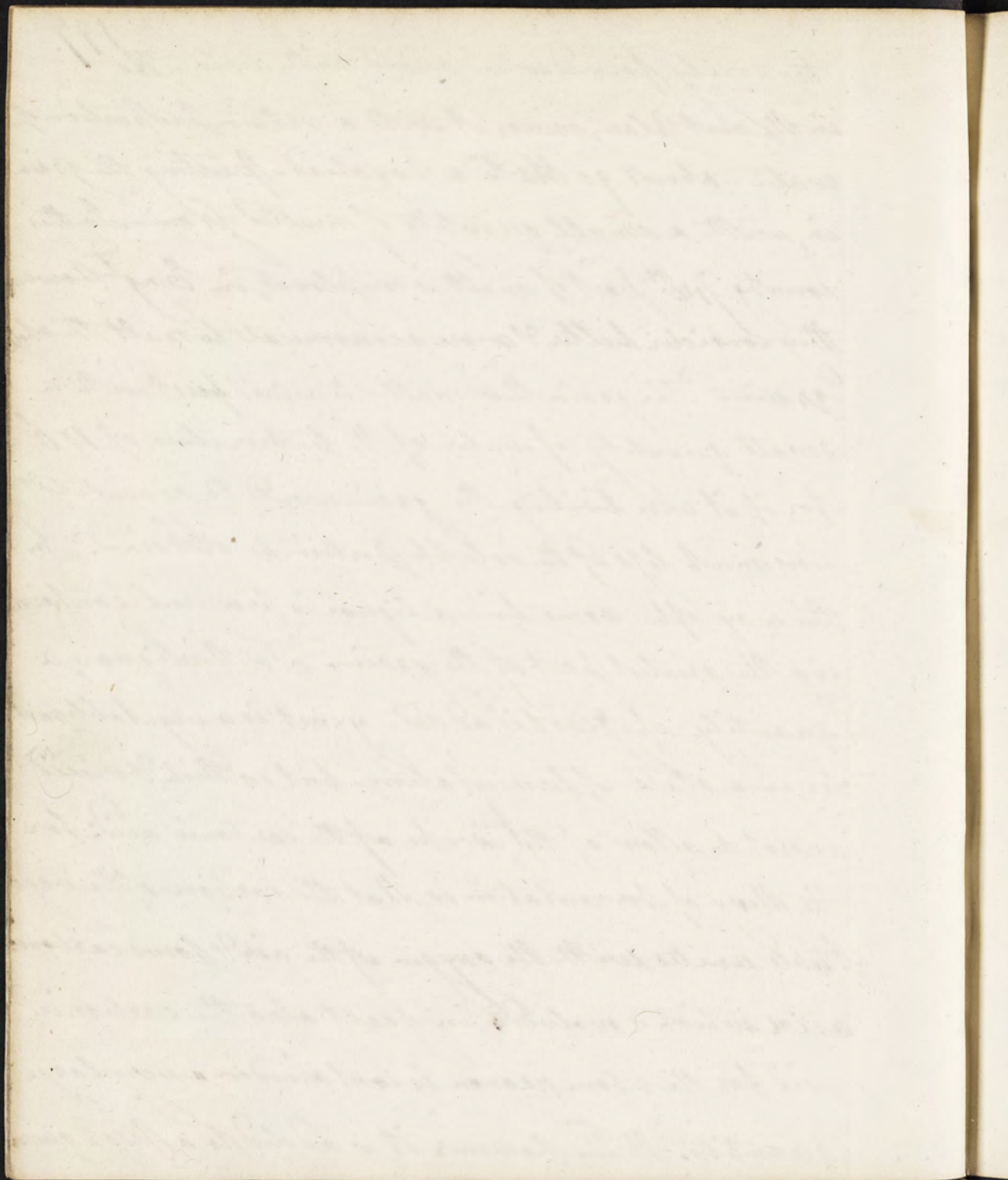


a greater profit. In making thin leather for the ¹⁹⁶
soles of ladies shoes - an improved method has been a-
dopted in France - it consists in boiling the leather &
then placing it on the surface of warm oil - the heat of
the oil should be sufficient to produce an evaporation
of the water in the leather - In this way the water is dri-
ven from the leather - which becomes saturated with oil
& afterwards impervious to water.

— The Vegetable Acid which is probably the
principal in point of importance, is Vinegar, or the
Acetic Acid. Of this much is known - & a great deal re-
mains unknown. It does not ^{exist} in nature in a pure
state - so far as has yet been ascertained. Its artificial
History will therefore claim our attention. Vinegar
is produced by the fermentation of the juices of fruits
or of a solution of the soluble part of grains - All
fruits & grains consist chiefly of carbon & hydrogen;
& as being most economical the Distiller chooses Rye
as the material out of which he makes his spirits &
his vinegar - In the first place, he gets it coarsely
ground - if it were ground finely - a paste would be

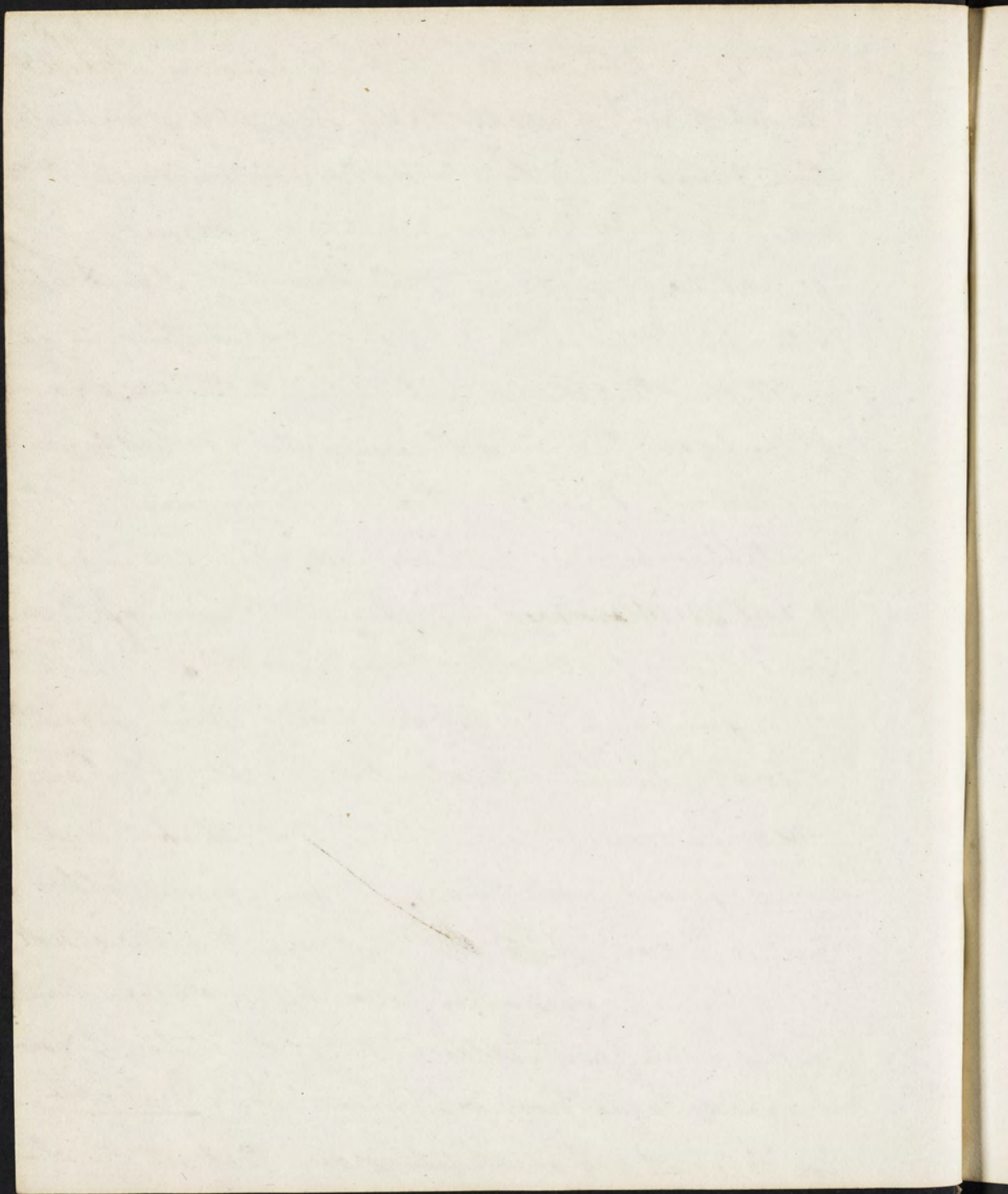


too easily formed when mixed with water - The ^{199.}
in the next place, mixes it with a certain proportion of
water - about 90 lbs to a hoghead - putting the grain
in, with a small quantity of malted grain - In this
country $\frac{1}{12}$ part of malt is employed, in Eng^d however
they consider better & more economical to malt the whole
grain - The grain thus malted is mixed first with a
small quantity of water of the temperature of 170°
for if it were boiling the grain would be coagulated &
thus much less of the soluble portion be obtained. In
this way after some time a liquor is procured contain-
ing the greatest part of the grain. To this liquor, a
quantity of yeast is added - yeast is a vegetable mat-
ter, in a state of fermentation - but so thick & viscid
as not to allow of the ^{free} escape of the carbonic acid: for
the theory of fermentation is, that the carbon of the vege-
table unites with the oxygen of the air & forms carbonic
acid which is evolved. In yeast also the carbonic
acid for the above reason is contained in a very large
quantity. When however it is added to a fresh quan-



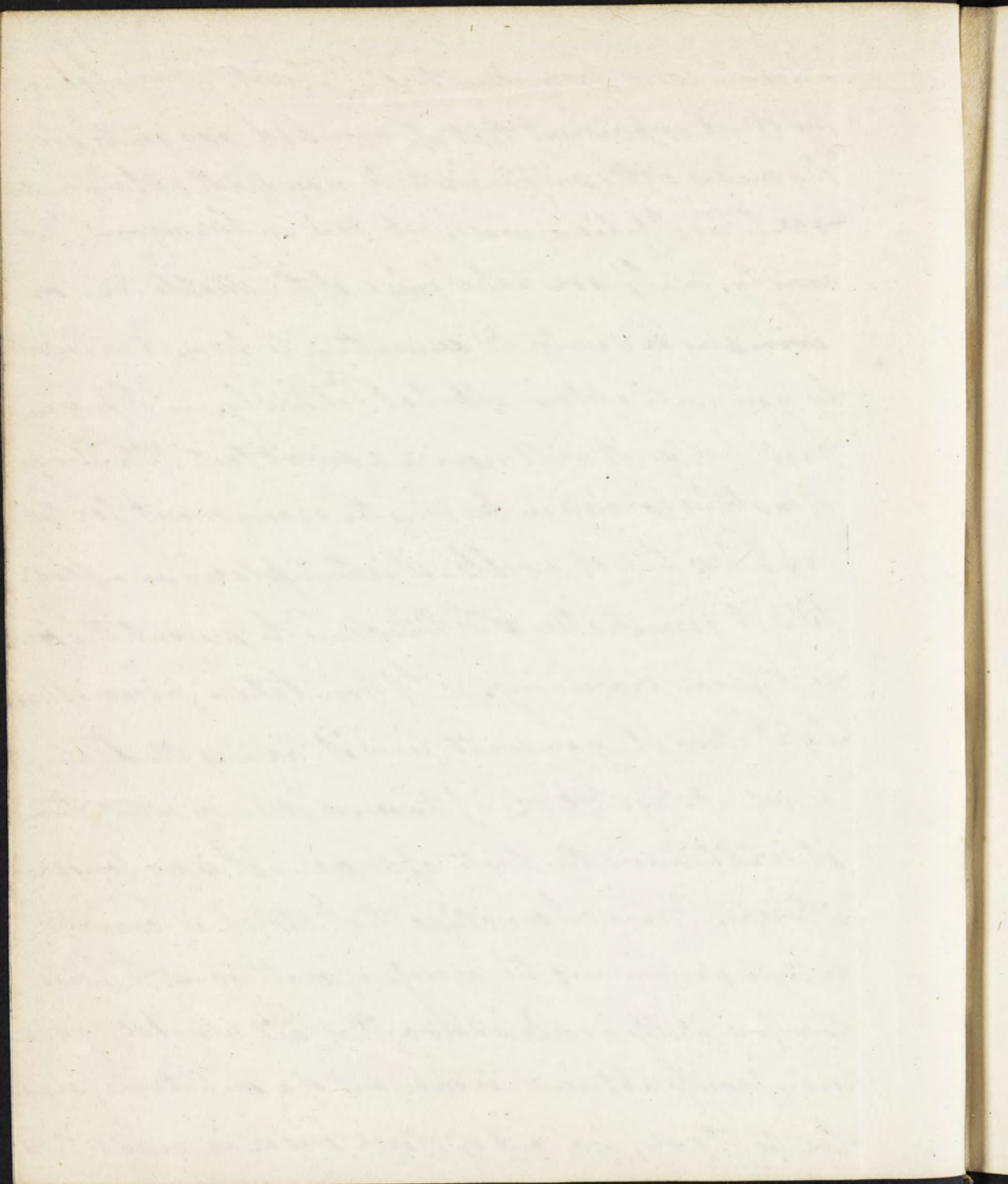
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-tity of vegetable matter - the proportions are altered &
The whole mass is quickly thrown in a state of fermenta-
tion: during which the atmospheric air uniting with the
vegetable carbon - a large quantity of carbonic acid is
generated. This is so much the case, that if you empty
a tumbler filled with water over a fermenting vat - you
will find that it will be filled with this gas. & now
as we know of no means of forming this gas but by uni-
ting carbon & oxygen; & as there is nothing present but the
vegetable substance & air, we have a right to infer that
the acid gas is ~~produced~~ produced by the union of the car-
bon of the vegetable with ^{the oxygen of the} atmospheric air. While
this is going on Alcohol or Spirit of Wine begins to
be formed, which is the object of the distiller. I am
very much inclined to the belief that alcohol is al-
ways formed from sugar. Grain consists of two
parts - If you take a piece of dough & wash it well,
till the water comes away colourless - you have then
washed away all the starch & left the gluten. Now
it appears to me from experiments - to be probable,
(for it is not yet absolutely proved) that all the al-



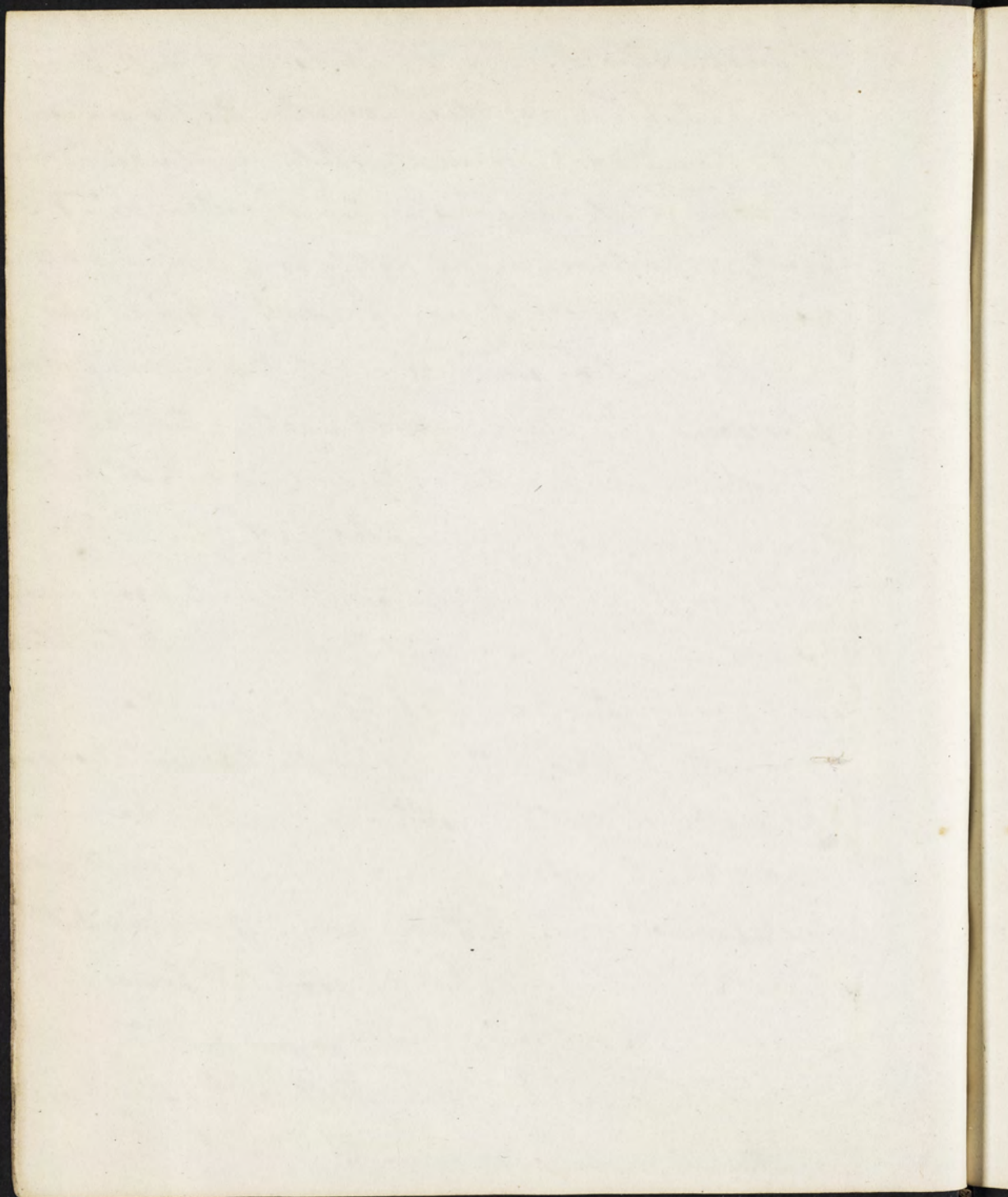
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- Alcohol comes from the starch. First. It is found
by direct experiment that if you add oxy gen to starch
by means of the sulphuric acid you will attain a sug-
ar. This I believe, was first done in Germany. Se-
condly. - If you take juice of the Maple &c. or
~~even~~ sugar & water - & cause them to ferment moderate-
ly you will obtain alcohol. Thirdly. - If you
malt barley - it will acquire a sweet taste. The process
of malting consists in keeping the grain moist for 30
or 40 hrs. till it swells - it is then placed on a floor
till it germinates. It is then dried to prevent this pro-
-cess from proceeding. If you take a piece of bar-
ley & chew it - you will find it having the taste
of wheat - rye &c &c. if however it be malted, then
it will have the taste of sugar - it is no longer
starch. Hence I conclude, that starch is converted
into sugar during the process of malting - I have
therefore pretty nearly shown, that all alcohol, by what-
-ever process obtained - is made out of a substance, simi-
-lar to starch, for out of starch sugar is made & out

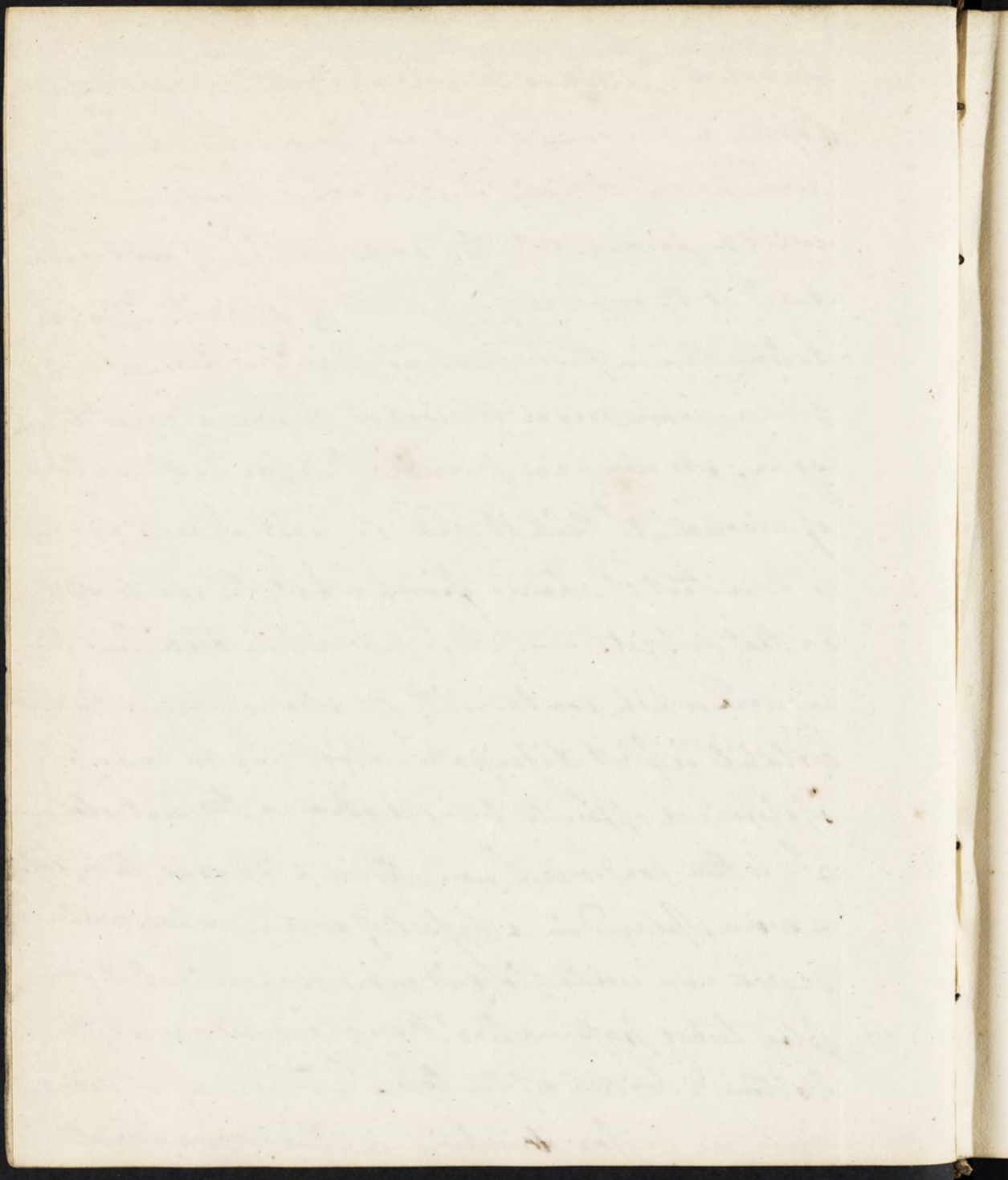


of sugar-alcohol. If this be true - it will become of importance to ascertain - whether the perfection of the liquor depends on the gluten or starch & whether some ^{other} article containing these substances in different proportions might not be employed more economically & more advantageously. And so also of bread, the question will arise, whether we cannot employ some other flour in making it - so that a better & cheaper bread may be obtained? - As to starch, there is at any rate, a singular fact - that if

be made with wheat flour they will grow heavy & spoil in a few days - but if made with the starch of the potatoe, they will keep light & good for 12 or 14 months - Now then, when the fermentation goes on as above mentioned, Alcohol will be formed - if however the atmosphere air be freely admitted, so much carbon will be taken away that very little spirit will be generated: so soon therefore, as the atmosphere of carbonic acid is formed over the vessel it should be covered. The necessity of this has been ascertained by direct experiment - If then a



quantity of alcohol be formed - & the process be not stopped but allowed to go on, the alcohol will be decomposed - & by the further access of oxygen vinegar will be formed. So then every particle of acid is produced at the expense of a particle of spirit. The gradation then in the fermenting process is from starch to sugar - from sugar to alcohol, & from alcohol to vinegar. As we have proceeded thus far in the history of alcohol I think it will be most advantageous to you that I should finish what I have to say on that subject. — It is procured by distilling the liquor which contains it; the alcohol being the most volatile is first dissipated - affording an example of chemical affinity being destroyed by heat alone. It is then condensed usually in a spiral tube, called a worm, placed in a vessel of water - where water is scarce you will find it more economical to employ tubes passing thro' troughs - narrow at the bottom & wider at the top. The uses of Alcohol - are - for drinking in this way a small

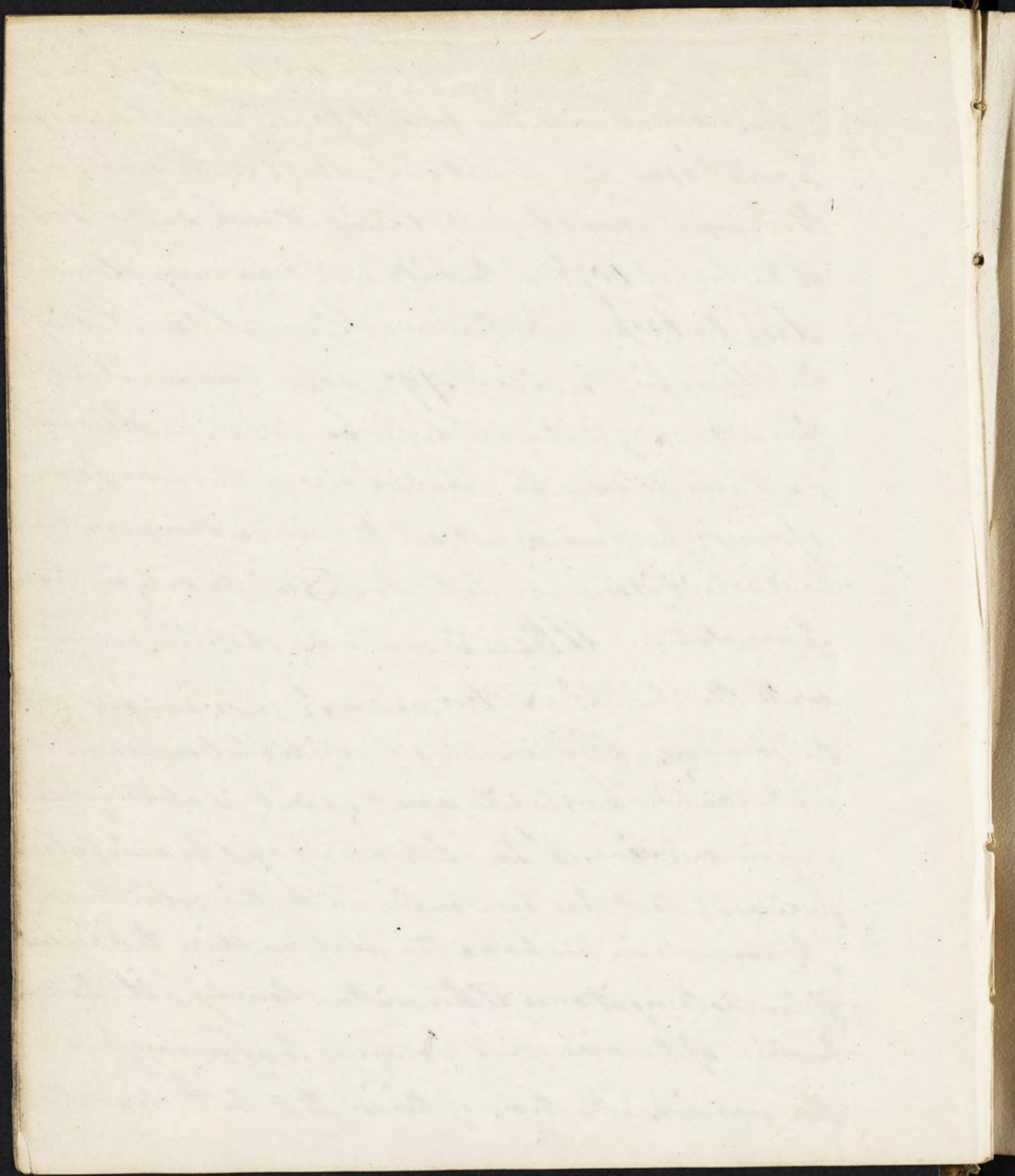


202.
quantity may be advantageous - while the excess is
injurious - whether on the whole it has been production
of more injury than good is doubtful. —

It is used also for making varnishes - For this it
should be very strong. Alcohol is the solvent of res-
ins - waxes of Gums. When we want alcohol very
strong there are two modes of procuring it. - Alcohol
will not dissolve any portion of a sulphate, nor
of a carbonate - The pure or caustic alkalies are
easily soluble in it - & from this solution we can obtain
the alkalies pure - Now If you take the sub-car-
bonate of potash - / salt of tartar / & heat it in a cruci-
ble to a red heat - break it - & pour it into alcohol - the
affinity of the heated alkali & water will be so great
that they will immediately unite - This process being re-
peated once or twice will separate all the water from
the Alcohol - If the alcohol should dissolve any
pure alkali - let some alum - very finely powdered be
added - the sulph^ric acid of this salt will unite with
the pure potash & be precip^d as sulphate of potash

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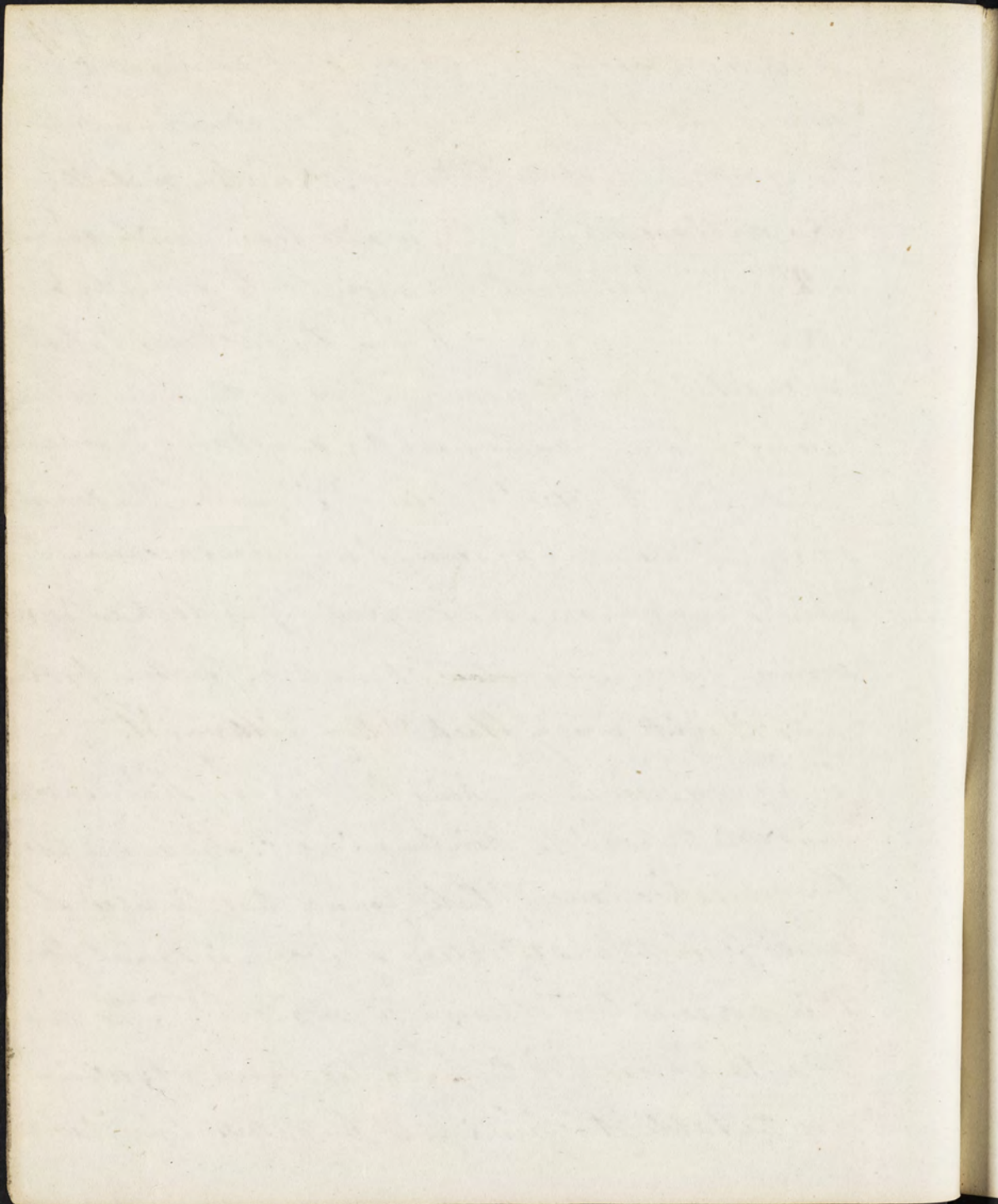
The earth of Bealum ^{me} ~~be~~ insoluble will also fall down
 & the alcohol will thus be left pure. For chemical pur-
 poses alcohol may be obtained strong by the second me-
 thod - which consists in distilling it over salt of tartar
 at the heat of 107° so that it shall come away slowly -
 drop by drop - In this way I have obtained it of
 the Specific Gravity of .792, when however it is of the
 Spe: Grav: .795 it will dissolve Copal. - Alcohol
 will also dissolve the essential oils in this way forms
 essences & perfumes: but all these invariably give the
 headache & it is much better to employ the oils in their
 pure state - Ether is made by distilling alcohol
 with the Sulph: & Nitric, or mus: acids: usually with
 the former. By conducting the distillation slowly &
 with caution a volatile, sweet spirit is obtained, used
 only in medicine. I have lately heard of a beautiful ex-
 periment - that has been made with this volatile spirit.
 It consists in heating a thin platina wire to a red heat
 & then holding it over Ether without touching it. The ^{com}
^{ignition} ~~combustion~~ of the wire will go on as long as any pure ce-
 ther remains. The theory of this is - that by the heat, the



Other is evaporated. - A stream of it passing over the wire in contact with the oxygen of the atmosphere ^{under a poor combustion} supports the combustion ^{isolation} of the Platina. No other metallic wire will answer - 1st - they would more easily oxidate
 2nd - The heat would be radiated to a greater degree — — — — —

When the Fermentation of vegetable matters goes on beyond the point at which alcohol is formed - we have another substance produced - vinegar - or the Acetic Acid of Chemists. The domestic uses of this are well known. - On a former occasion I showed how vinegar can be deprived of its dark colour without injuring its ~~solid~~ strength or flavour - by shaking it with ivory black & then filtering it.

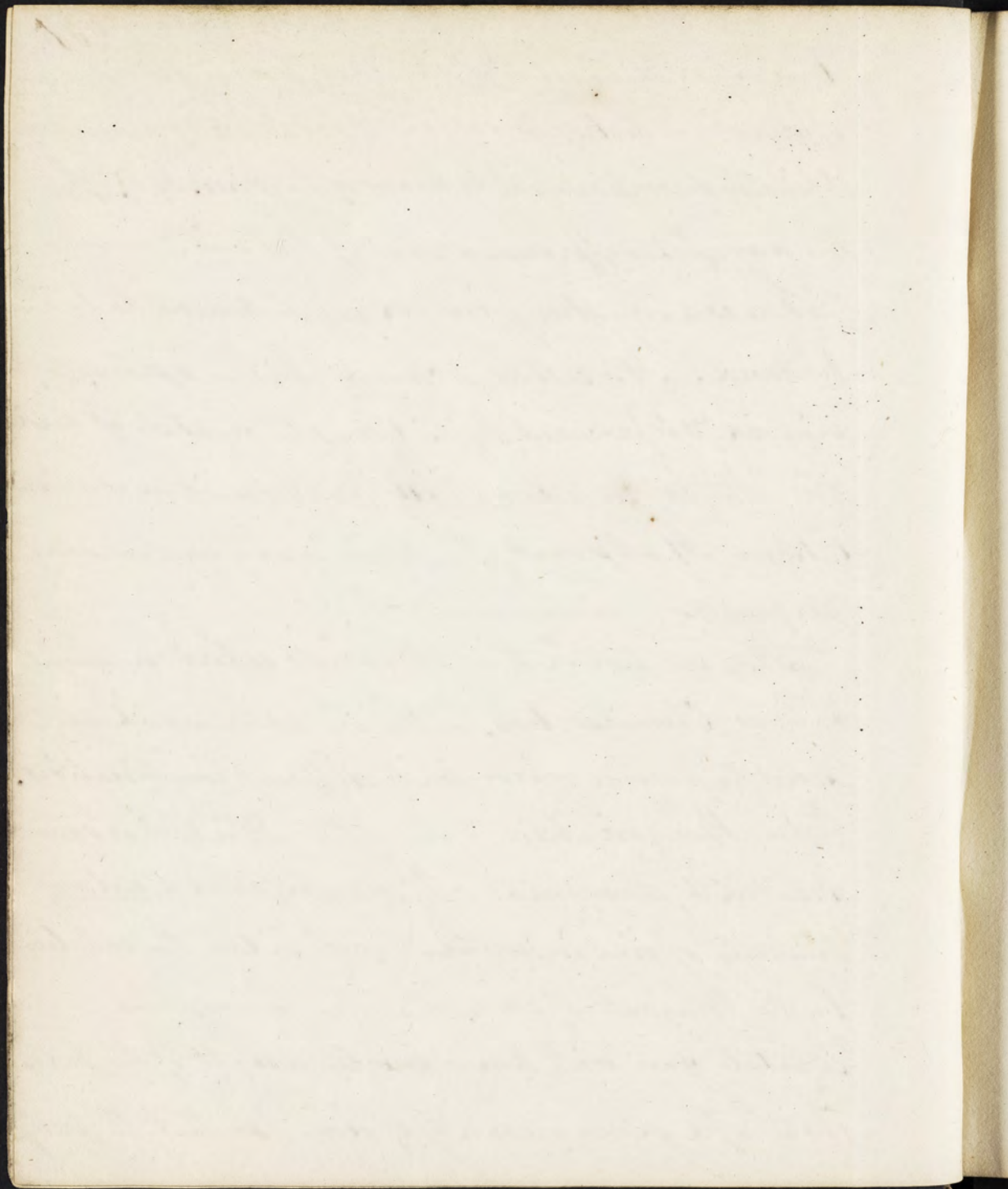
Vinegar is used in making the Sugar of Lead - in making white lead & in painting Calico. The manufacturers of calico have, of late, found that the acid obtained from the distillation of wood - is equal for their purposes to that usually employed. The acid so obtained is called the pyro-ligneous acid; when used for the table it is purified by saturating it with



lime - percolating it thro' charcoal, burning it so as more effectually to destroy the carbon - & tar in its composition & finally decomposing it by means of the mur: sod: In this way I have procured some of this acid.

There is a very strong vinegar which deserves to be introduced. It is called Dr Henry's distilled, aromatic, vinegar. It is procured by distilling the crystals of verdigris - the ^{it} copper is completely freed from it by a redistillation - At present, I believe is only used in some perfumes.

There are two or three other acids which are useful only as chemical tests. There are some which will detect the presence of iron in its different combinations. The Benzoic Acid is one of these. It is used as saturated with ammonia. If you dissolve a certain quantity of iron in water & precipitate the solution by the Benzoate of ammonia - then by weighing the precipitate, you will know ~~how~~ the weight of the precipitate of a given quantity of iron - so that the precip



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itate will be the exponent of the quantity of iron held in solution. In this way you can not only detect iron in any mineral water but you can discover how much is present. The Succinic Acid is another test of iron - not so good as the former - but may be employed in the same way. The Oxalic Acid is procured by boiling Citric Acid on Sugar, by which the oxygen of the acid is combined with the sugar, forming oxalic Acid. This is a delicate test of Lime - separating it from its combination with muriatic acid - which combination is very strong -

This finishes all that I have to say of Acids - there are several others which are little known & still less used - Four times as I trust, be much more profitably spent - than by attending to any other qualities I could say about them - I therefore proceed to the consideration of Salts -

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Caloric is that which produces the sensation of heat. The word heat was formerly indiscriminately used to express both the cause of the sensation - & the effect or sensation produced by that cause. It became necessary to invent a word which should name the cause only, but unfortunately the name adopted involves a theory, as it supposes that there is some substance which is the matter of heat. Whether this be the case or not - we shall see presently. The question is, Whether heat is produced by a distinct substance - or matter - or whether it is only a property of matter arising from an invisible, imperceptible motion of the particles of bodies. A majority of Chemists embrace the opinion, that it is matter, "sui generis". Others - particularly among the English adhere to the Old English notion, that it is only a property of all matter. At present in using the term caloric, we appear to adopt the opinion of its being a substance but I would wish it to be understood - that I use it as it were, only for the moment - waiting for fu-

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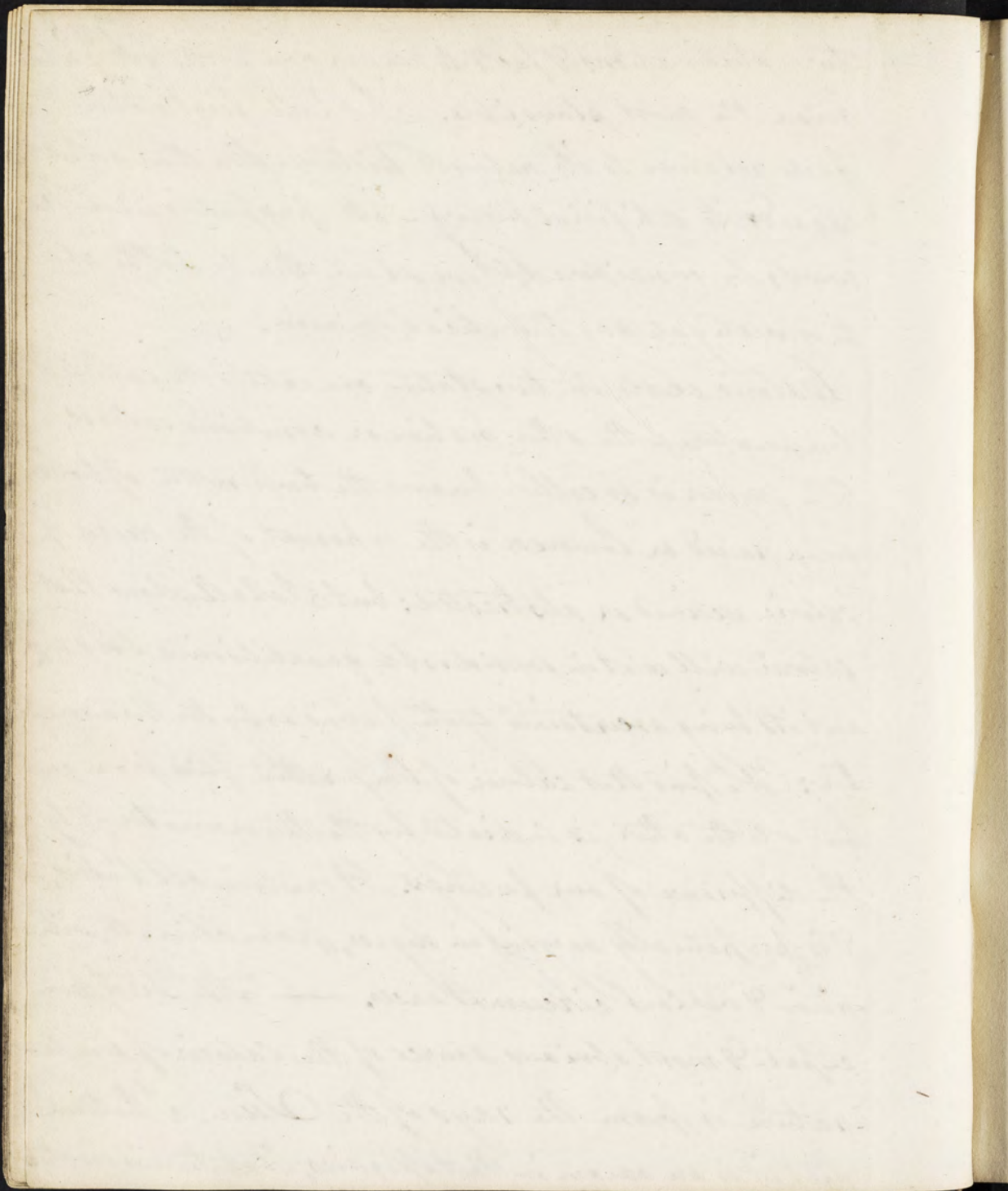
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ture observations & facts to render one or the other opinion the most plausible. I shall first notice the facts relative to its natural History - then those which regard its artificial History - its properties will afterwards be considered, & we shall then be better able to investigate any theoretical opinion.

Caloric exists in two states - one called the caloric of temperature - the other native or combined caloric.

The former is so called - because the temperature of bodies when raised or lowered is the exponent of the degree of caloric received or abstracted: but I shall show that caloric will exist in considerable quantities in a body, without its being ascertained by the feeling or by the thermometer: We find that caloric of temperature flows from one body to the other, is indicated by the thermometer - & by the difference of our feelings. It exists in all bodies, & is perpetually varying in degree, from climate, situation & various circumstances. — The first, principal

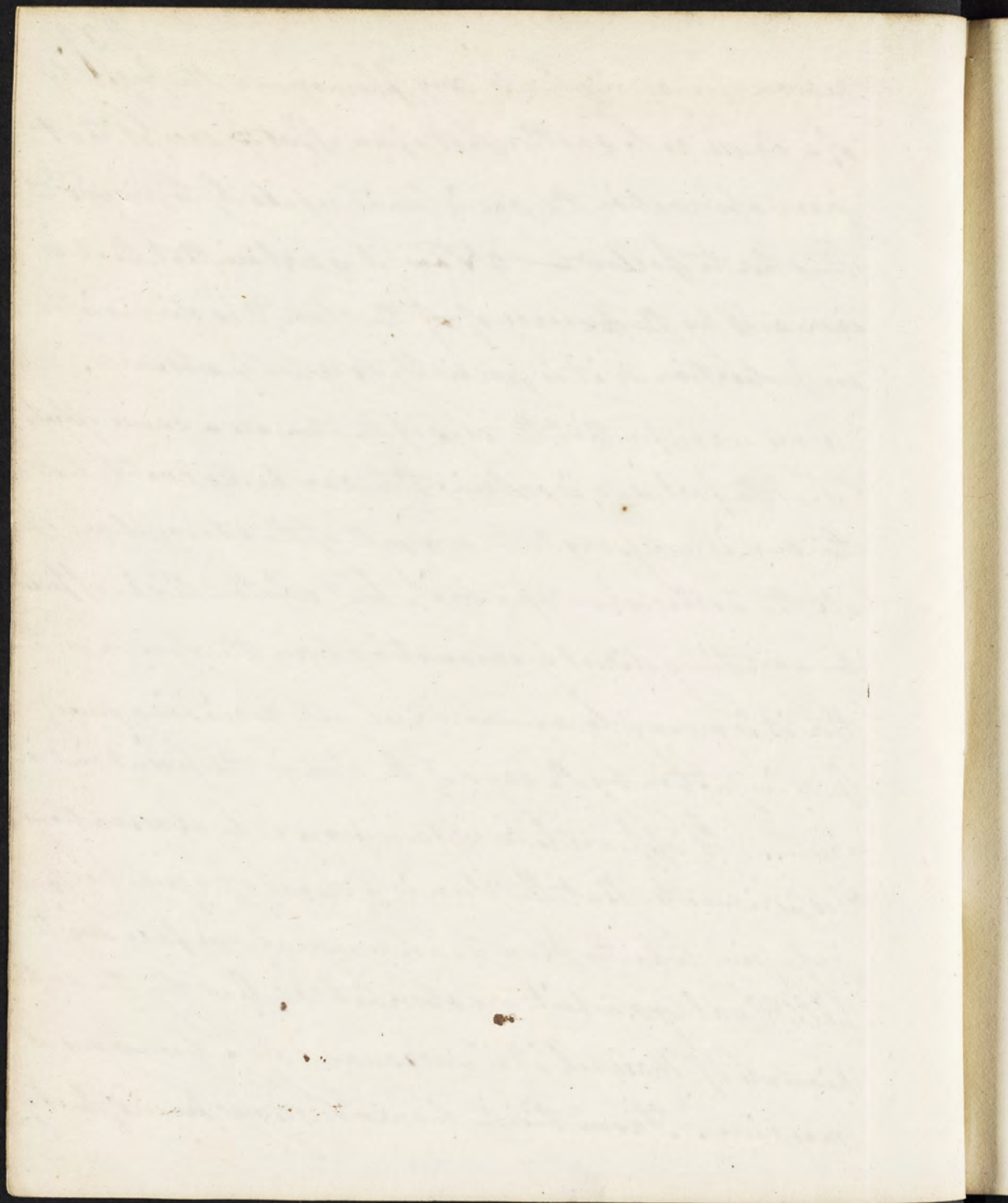
& most obvious source of the caloric of temperature is from the rays of the Sun. I believe that it is an axiom in Metaphysics; that there is another



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reason for ascribing to any phenomenon^{or} the property of a cause or to another that of an effect & except that from observation the one is found regularly to precede & the other to follow — Now it is certain, that heat is increased by the presence of the Sun, & is diminished in proportion as it is partially or wholly obscured.

Hence we infer that the rays of the Sun are a cause of heat. That the fact is so, is certain; there can be no doubt, that the sun is necessary to the warmth of the atmosphere & of all the bodies enveloped in it, but whether this is effected by any thing direct by emanating from the Sun or whether it is owing to an universal all pervading fluid, put in motion by the rays of the Sun is the point in dispute. It appears to be certain from late observations & experiments that the Sun is a dense, opaque body, possessing like the planets, an unequal surface with hills & valleys, which are observable; that by the experiments of Herschel it is surrounded by a luminous atmosphere. From this the luminous rays proceed; but of



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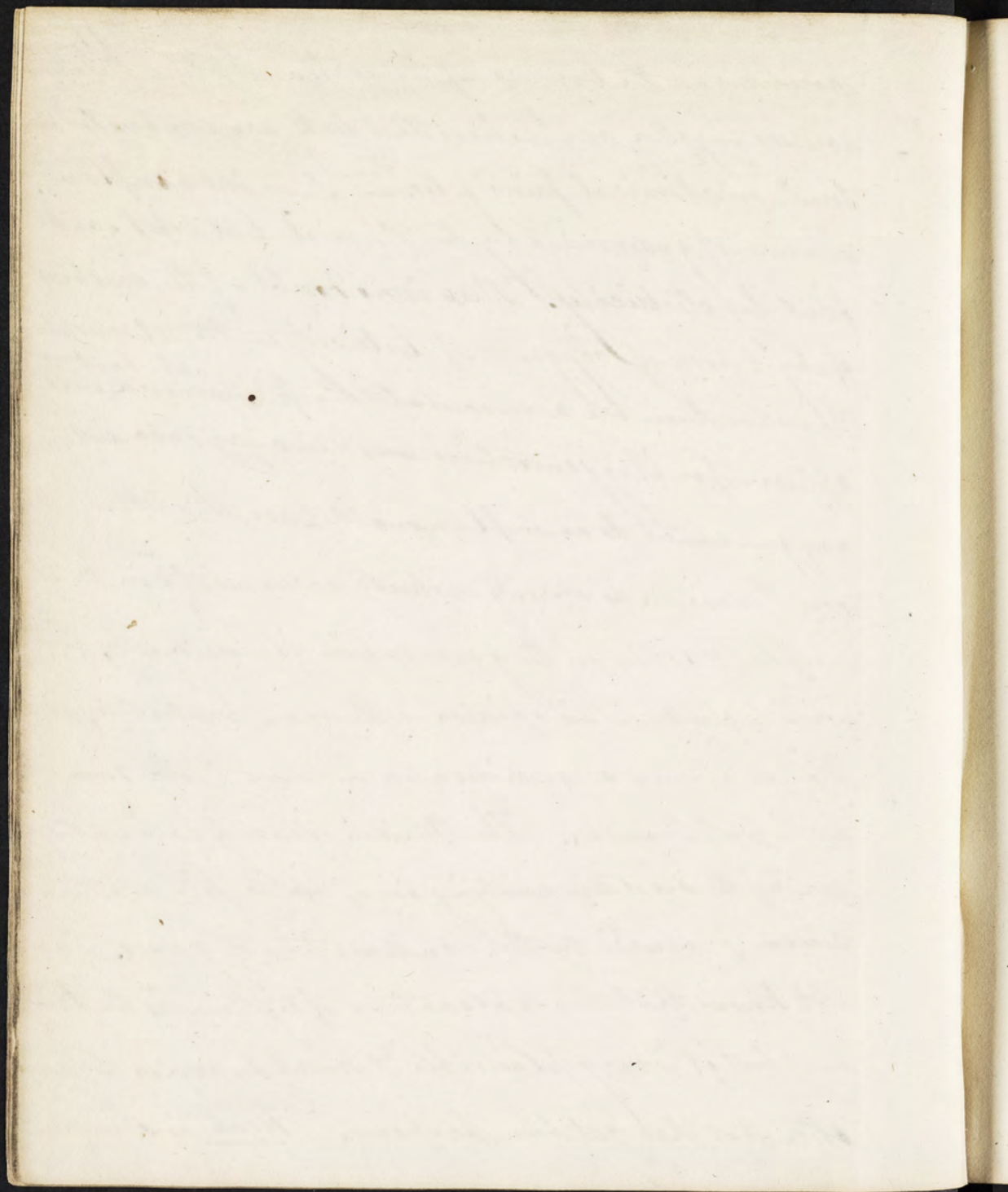
What nature they are - how they proceed - & what is the connection between our atmosphere & that of the sun - are questions - which can be answered by no facts yet known -

At the same time it is certain, that ^{there is} a great quantity of natural caloric, already existing on the earth - pervading all matter - It is perpetually varying whether the sun is present or not. When the sun is absent, heat is felt - not so strongly - but as distinctly and as certainly - therefore the cause of this must exist when the rays of the sun can no longer act as a cause. So also we can excite heat independent of the sun's rays. Hence it is probable that something exists - which is the matter of heat - that it pervades all bodies & is made sensible by the sun's rays. Unless we take for granted that it is a matter "sui generis" we cannot account for facts. M^{rs} Euler & Huygens were of opinion that heat & light were fluid bodies pervading all space & all substances & is brought into action by various exciting causes.

We find that heat exists naturally - accompanying Thunder & lightning - & also attending chemical decom-

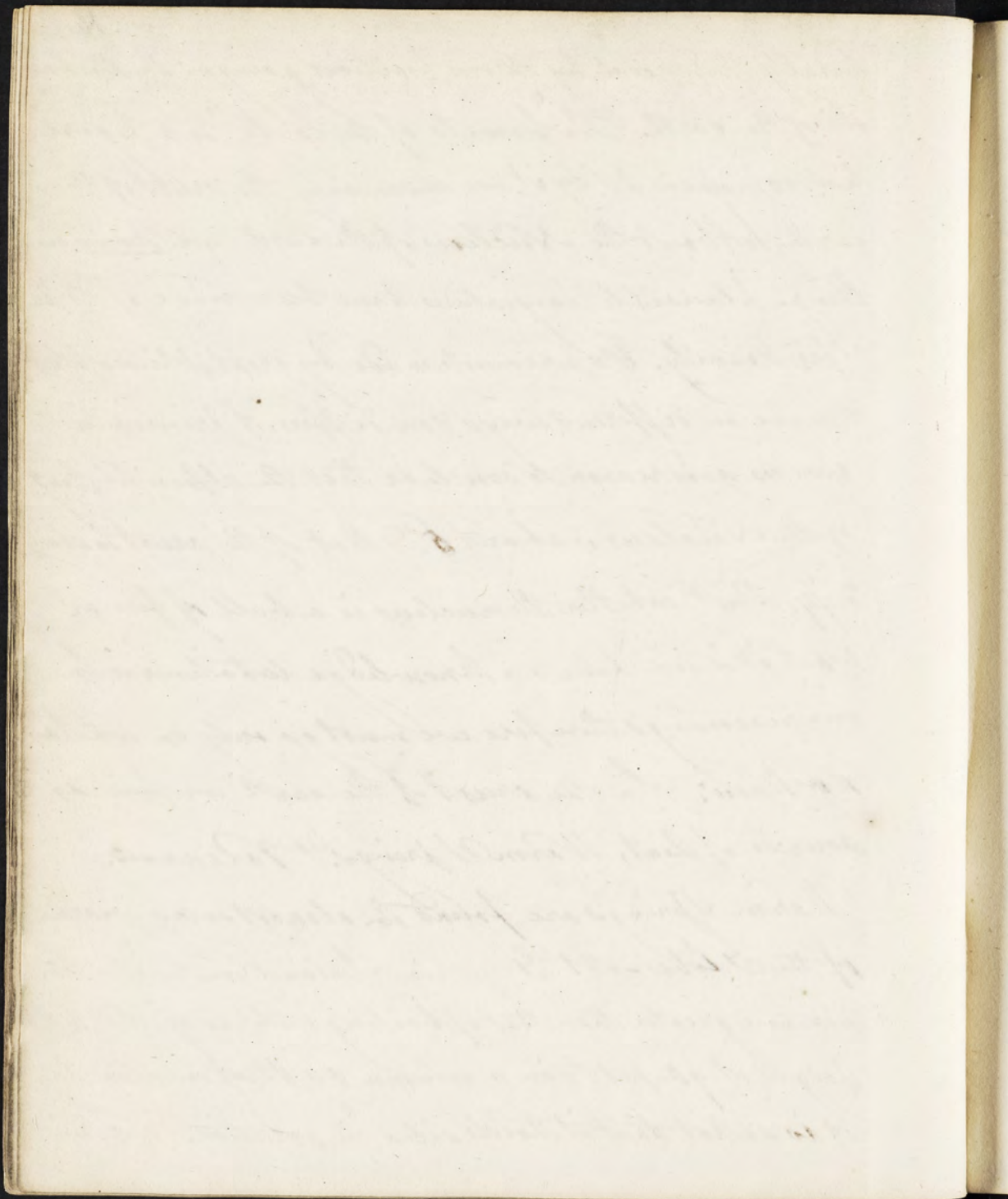


positions in the bowels of the earth. I place these two sources together as I believe that both are conducted entirely on chemical principles. — There is no inflamm^d mixture of gases made by the chemist — but what can be fired by electricity. There is no doubt of the existence of hydrogen & oxygen & of electricity in the atmosphere & where there are accumulated the phenomena^{of heat}, will appear — for it is generated in any & in every case where oxygen unites to an inflammable base. Lightning therefore I consider as arising from electricity accumulated in the atmosphere & acting on the gases which it there meets, thus forming water. This opinion is the more probable, as there is always a considerable increase of the rain after a clap of thunder. The thunder is easily accounted for by the sudden rushing in of air to fill up the vacuum produced by the condensation of gases. I do not know that this explanation of lightning is the true one, but it is very plausible & much superior to any other that has yet been proposed. Heat is also na-



naturally produced by decompositions going on in the bowels of the earth. The "bowels of the earth" is a figurative expression - & by it we mean only the crust of the earth. About the nucleus of the earth we know nothing - plausible conjectures have been made of its specific Gravity. Experiments made by great Philosophers & made in different ways & on different principles - give us good reason to conclude that the Specific Grav. of the nucleus is about 5 - & that of the crust is about $3 \frac{1}{4}$. But whether the nucleus is a ball of fire or what it is we have no knowledge whatever - In our reasonings therefore we must go only on what we do know. In the crust of the earth we find as sources of heat, Warm Springs & Volcanoes.

Warm Springs are found in almost every quarter of the Globe - at Geyser in Iceland Water of a temperature greater than that of boiling water is ejected to the height of 90 feet - & in a column 19 ft. in diameter - it is so hot that it holds silix in solution. Warm



Springs are also found in Engl^d - & also in this coun-
 -try in Virginia. Now these must have acquired their
 heat from something in the earth. Nature has so many
 ways of executing her own phenomena - that it is absurd
 for us to confine her to any particular way. But still
 as we can only reason from ^{what} we know - from what we
 can execute in our petty laboratories & from what we can
 occasionally observe going on in the great laboratory
 of Nature, we may venture to hazard a conjecture of
 the method pursued in producing natural phenom-
 ena. I believe that most warm springs are found
 where there is a great quantity of Iron pyrites - & in
 Volcanic countries where sulphur exists in abundance.
 We know from direct experiment - that when sulphur
 iron & moisture get together - the heat produced - is
 truly prodigious; as in this way we can & have made
 artificial Volcanoes - & by this process all the green
 nitric acid of commerce is obtained - When sulphur
 iron & moisture are mixed - the moisture is decomposed

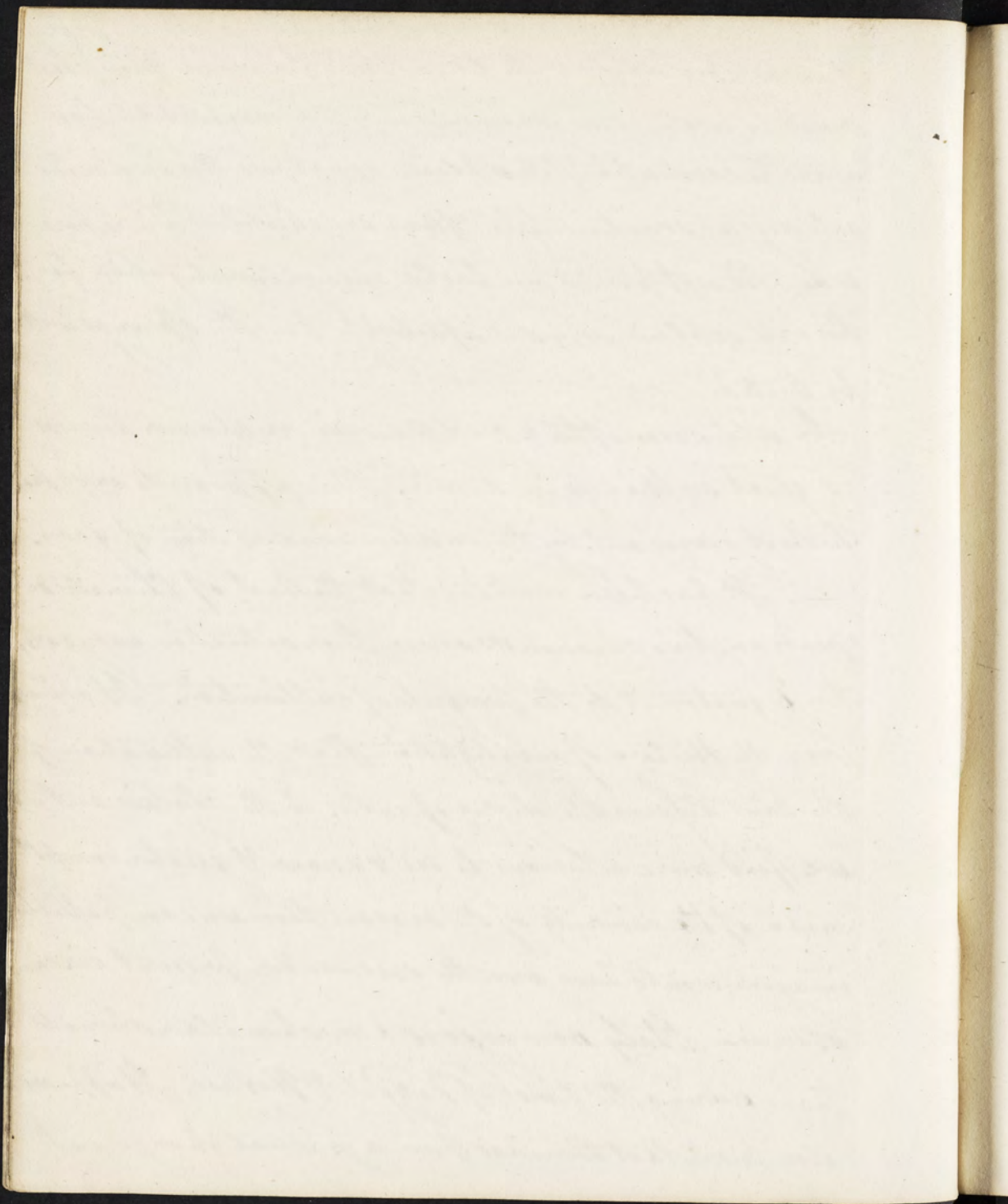
x Erroneous both in fact and inference

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& its oxygen unites with the sulphur - In which process heat must be evolved - as where ever oxygen & a combustible base unite, a combustion takes place - sometimes this in a moderate degree sometimes fire & flame are elicited - Therefore we need not proceed any further in our investigation - for this will explain very satisfactorily how the springs will be heated -

In all cases after a sudden rain or shower, there is a great softness in the air. This appears to arise from the heat given out by the sudden condensation of gases.

— It has been observed that the heat of climates depends on two circumstances - their situation as regards the Equator - & the progress of cultivation. It appears from the History of civilization that the cultivation of the land lessens the degree of cold; in the classic authors we find more allusions to ice & snow - & greater complaint made of the severity of the seasons than we can possibly imagine would have been the case under present circumstances - Italy now enjoys a much milder climate than during the times of Virgil & Horace. It appears also to me that there has been a gradual change in the



climate of Pen^a during the last 25 yrs that I have been
 a resident in it, so that upon the whole, it is considerably
 more mild. Heat & combustion are not only produced
 by chemical decompositions in the regions of the air &
 in the bowels of the earth but also by the contact of
 different substances - cotton & oil - flax & oil - char-
 -coal moistened with oil &c &c will often fire sponta-
 neously - I have no doubt that many buildings, espe-
 cially manufactories have been ~~thus~~ destroyed in this
 way - the burning of which has been attributed to vic-
 design - In Eng^d Hay Stacks after the fire that
 climate is so moist that the grass is seldom properly dried
 in consequence of which - affected by the weight of the
 stack the moisture is decomposed - the oxygen is imbibed
 by the Hay which becomes charred - the hydrogen from
 the heat generated fires - & the whole is thereby infl^d

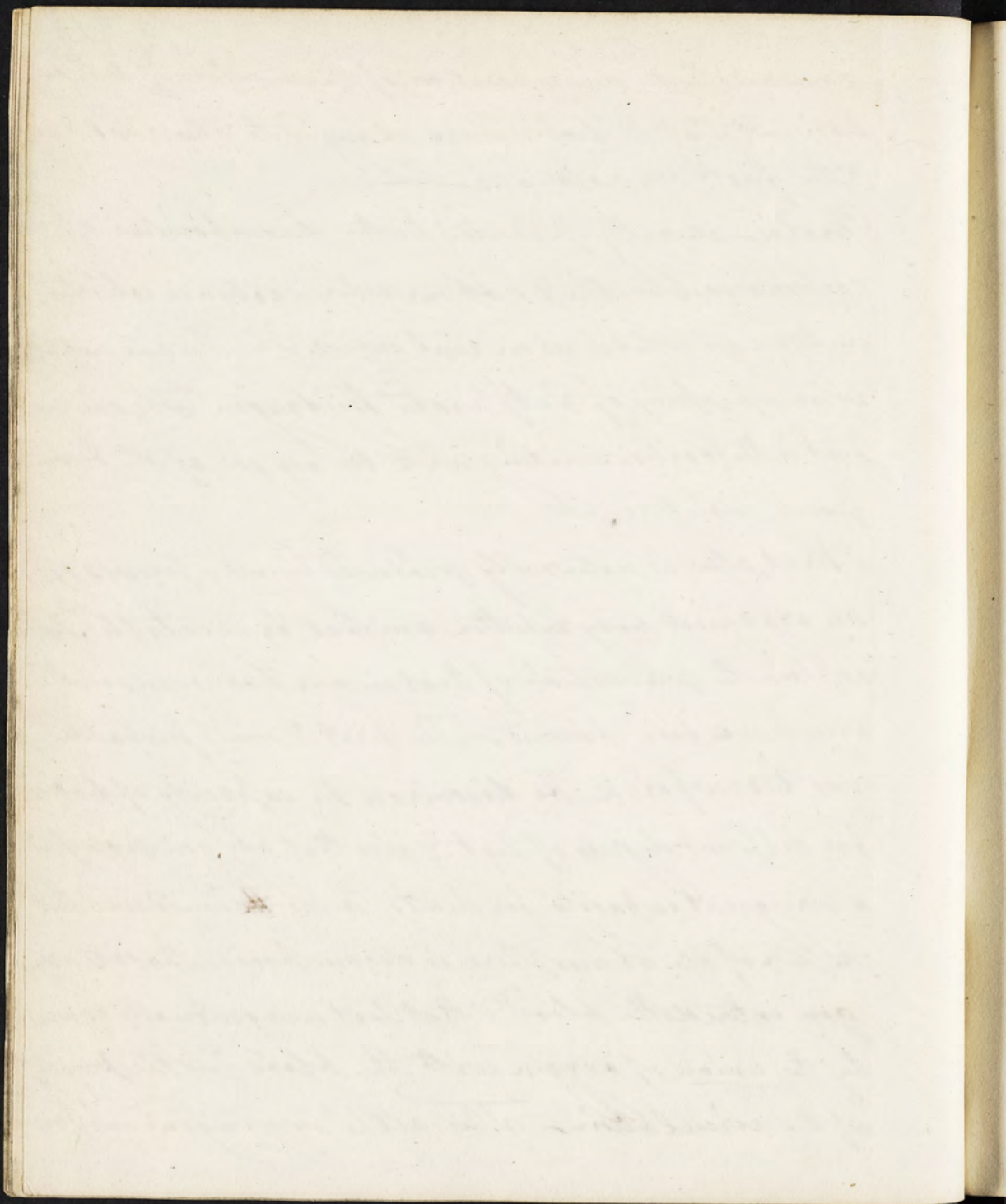
— There is a kind of spontaneous combustion
 of the human body - arising from the excessive use
 of ardent liquors - There are 8 or 10 cases well
 authenticated & recorded of persons being actually

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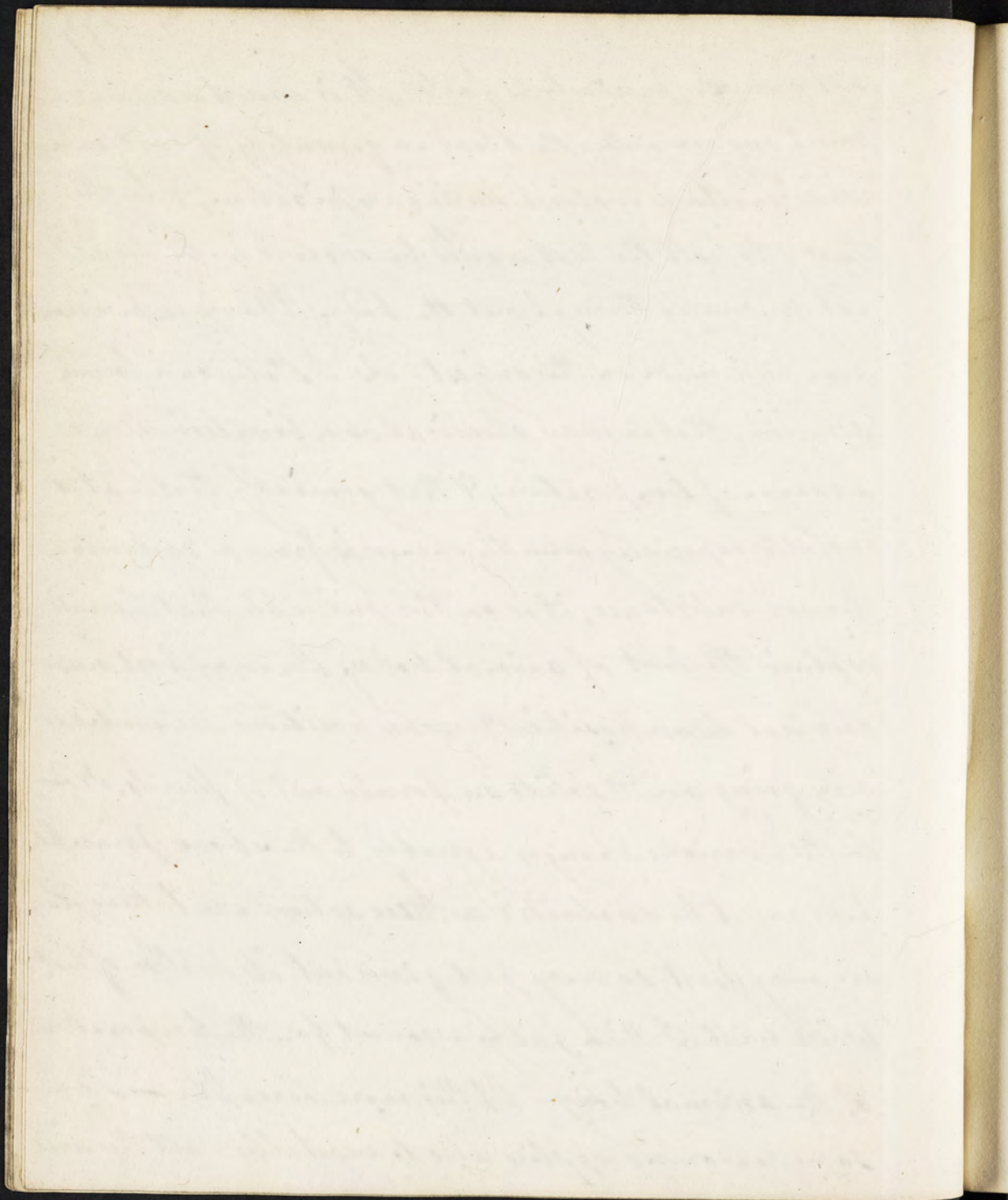
consumed by the decomposition of the moisture of their own bodies - & that the bodies were changed to charcoal dust. The facts are notorious.

Heat is naturally produced by the decomposition of carbonaceous matter & vapour where carbon is collected in large quantities - as in coal mines. This I have noticed when speaking of Sulphurated Hydrogen. The source of heat is the carbon uniting with the oxygen of the decomposed moisture.

Heat also is naturally produced by every process of an organised body whether animal or vegetable. To explain the production of heat in our bodies - many theories have been formed - The first & most probable was Crawford's. He discovered the capacity of bodies for different degrees of heat - & also that oxygen possessed a very great capacity for heat. Hence ~~he~~ ^{he} concluded that the air of the atmosphere is decomposed - that its oxygen entered the blood & that heat was gradually evolved by the union of oxygen with the blood in the progress of the circulation - This altho' very ingenious, does

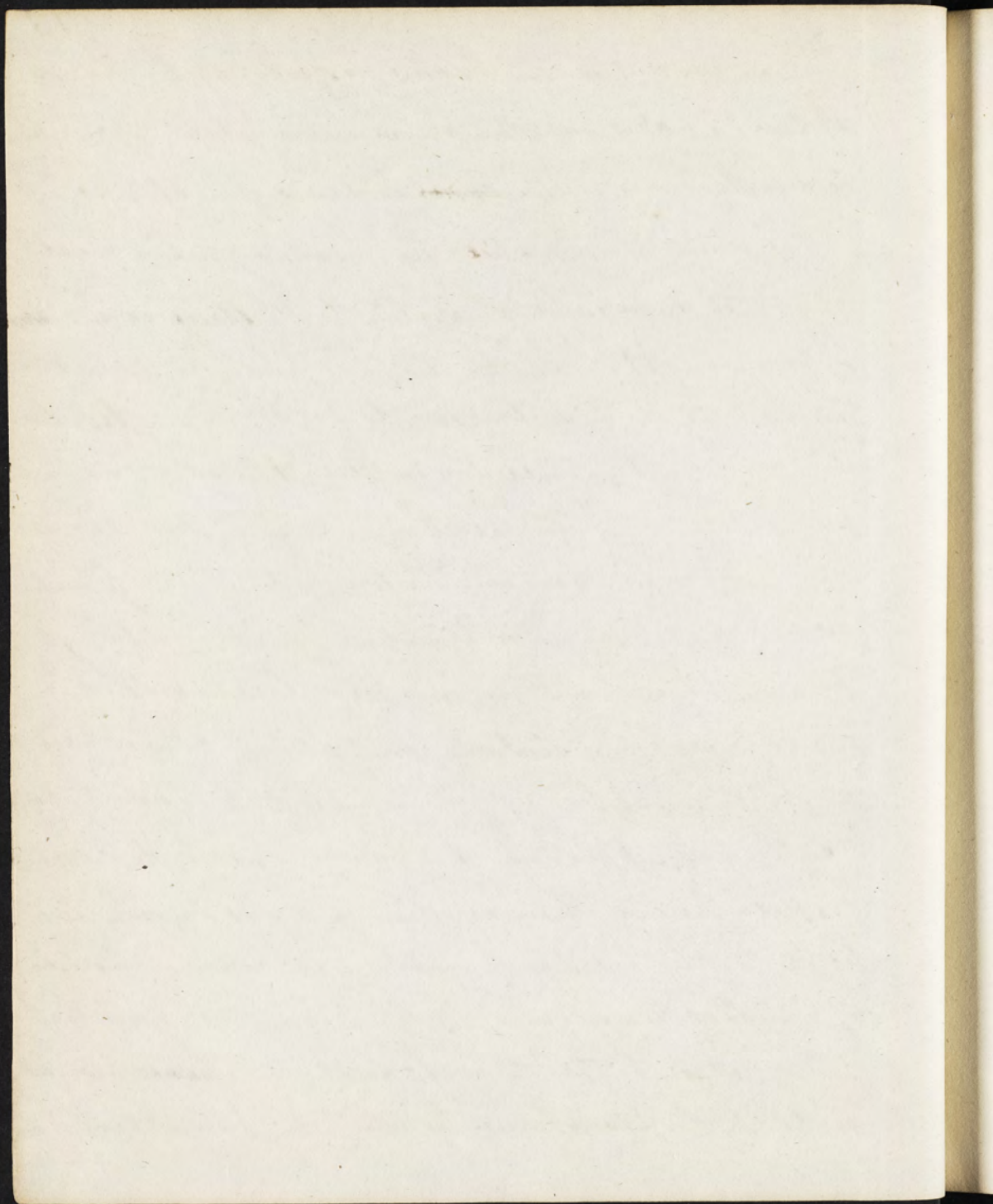


not answer precisely to facts. It is uncertain how much oxygen enters the blood - a quantity of carbonaceous matter is evolved during respiration, & by this theory too all the heat would be evolved in the lungs & not gradually through out the body. Many experiments have been made on this subject. As I stated on a former occasion - that in every chemical combination there is a change of temperature, & that generally that heat is evolved, especially when the change is from a rare into a denser substance, it is on this principle that I would explain the heat of animal bodies. In every part new chemical decompositions & recompositions are continually going on - & solids are formed out of fluids. & now in these various changes agreeably to the above principle heat must be evolved: & as these actions are taking place in every part - so every part gives out its portion of heat which will I think fully account for the temperature of the animal body - Of this more hereafter - The same reasoning applies also to vegetables - all this will

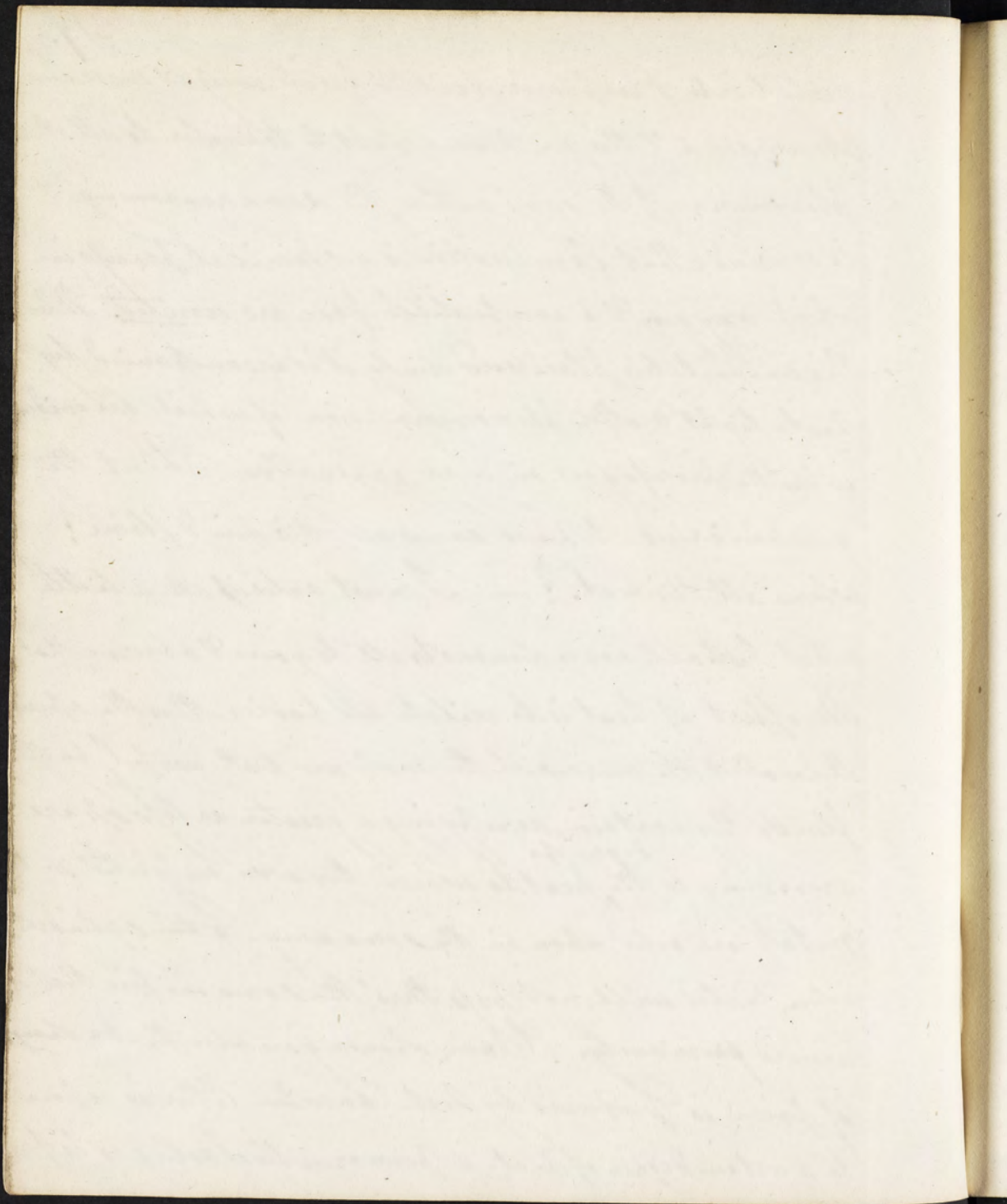


be more evident when I come to speak of the power of living bodies, whether animal or vegetable, resisting to a certain degree the ~~extra~~ increase of heat & cold.

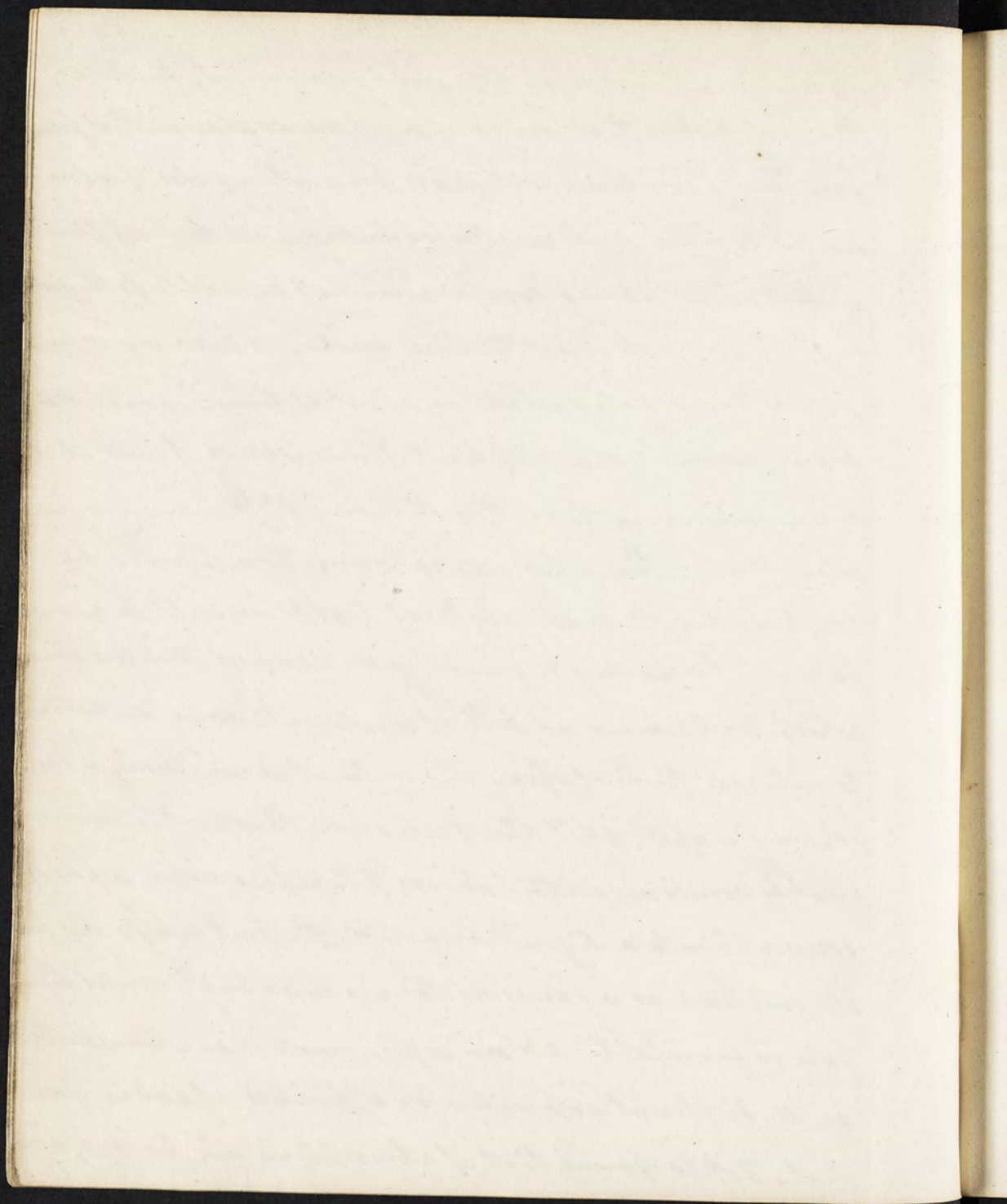
Having now noticed the means by which heat is generated naturally I proceed to the artificial means of procuring it. — In the first place we procure it by combustion, by setting fire to bodies. When two bodies meet, one being already on fire, & the other combustible — as when a lighted match is applied to dry shavings the process which goes on, is entirely chemical. You have seen, that unless oxygen is present no bodies will burn, & burning bodies would be immediately extinguished. In all cases oxygen maintains combustion. & this it does not by remaining but by combining with the burning body & entirely disappearing. We can only argue the case not perfectly known, from cases which we do know — we know that by burning phosphorus in confined portion of air — that the oxygen of the air disappears — now as it could not escape thro' the vessel — it must have been absorbed by the phosphorus — by which the phosphorus is con-



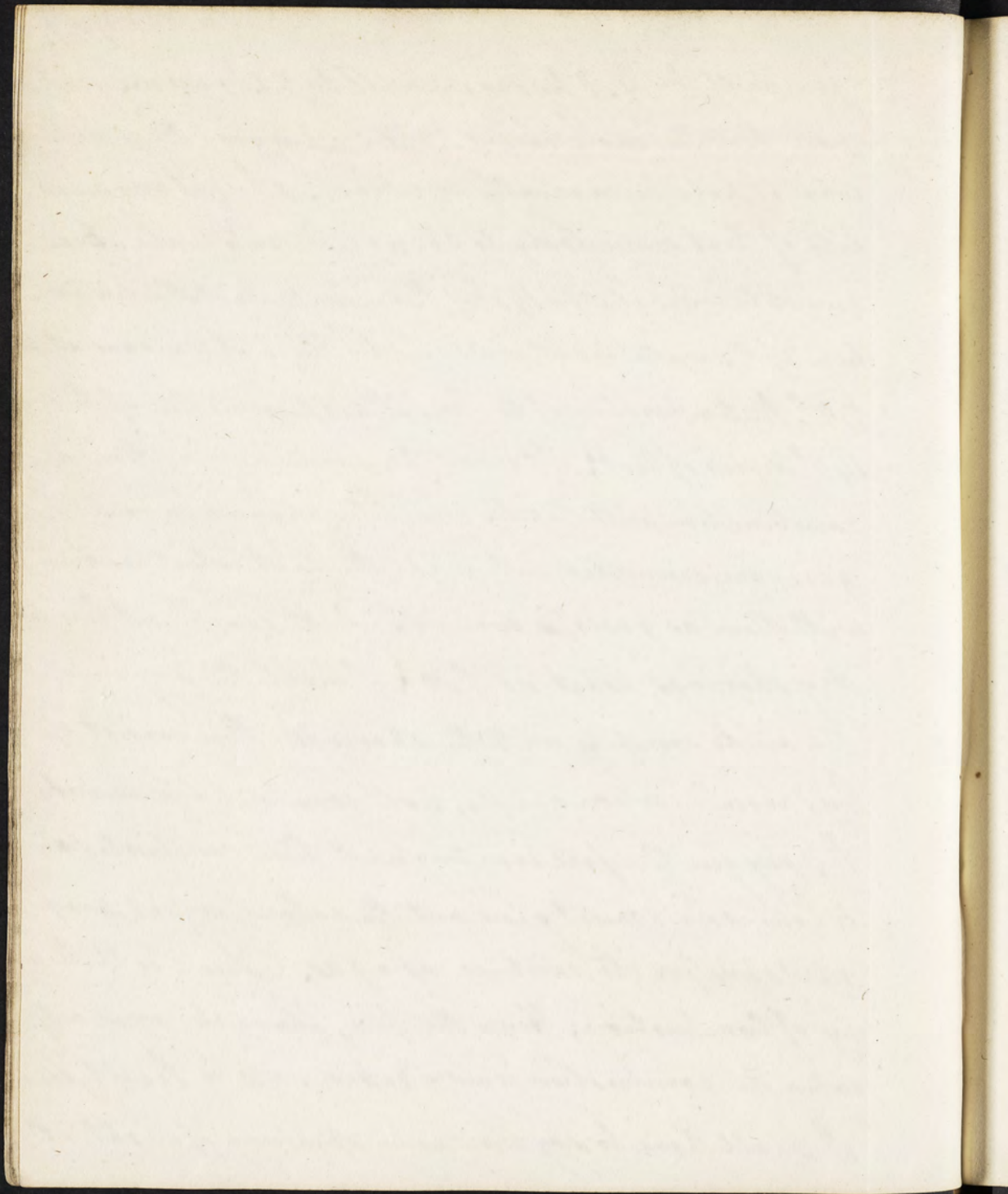
-verted into Phosphoric Acid - & has its weight increased.
 As we see all this, we have a right to transfer to all other
 phenomena of the same nature, the same reasoning - &
 to conclude that Combustion is a chemical process in
 which oxygen & a combustible base are united. When
 this union takes place suddenly, it is accompanied by
 heat - light & other phenomena - none of which are evident
 when the process goes on very gradually - But the
 question arises - Whence comes all this fire & flame?
 whence all this heat? - I must anticipate a little
 what I shall soon demonstrate to you - & observe, that
 the effect of heat is to dilate all bodies - Thus the spirit
 thermo^m & the mercurial thermo^m are both useful by the
 fluids they contain, occupying a greater or less space
 according to the ^{degree of} heat to which they were subjected. All
 metals are acted upon in the same way - a tin cylinder
 when heated will not pass thro' the same orifice that it
 would previously. I have shown you also, that a change
 of form is produced by heat - as when ether is exposed
 to a certain degree of heat - a permanently elastic gas is form



Hence all bodies are rarefied by caloric. If this be so,
 then all bodies that are rare, must ~~be so~~ assume that form
 from being combined with heat: for nothing else has been
 added to them: Heat must also be required to keep them
 in that state, & being combined is not sensible to the feel-
 ings - & does not affect the thermometer. Mercury when
 frozen & in a solid state is about 15 times heavier than
 water, when heat is applied & it is rendered fluid, it re-
 mains permanently so - & is then only $13\frac{1}{2}$ times heavier
 than water: Thus also ice is converted into water by
 combining it with heat - abstract heat, & ice will be again
 formed - by adding a greater quantity & convert it into vapour
 which will remain so, till it meets with some substance
 to separate the heat from it - when it is condensed, again
 forming water. All these facts show that heat is perma-
 nently combined with bodies: & therefore when a gas is
 converted into a liquid or solid - the heat necessary for
 its existence as a gas is no longer wanting & must there-
 fore be given out. Now experiments have been made
 on the different capacities or affinities of bodies for
 heat - & it is found that if atmospheric air be one, only

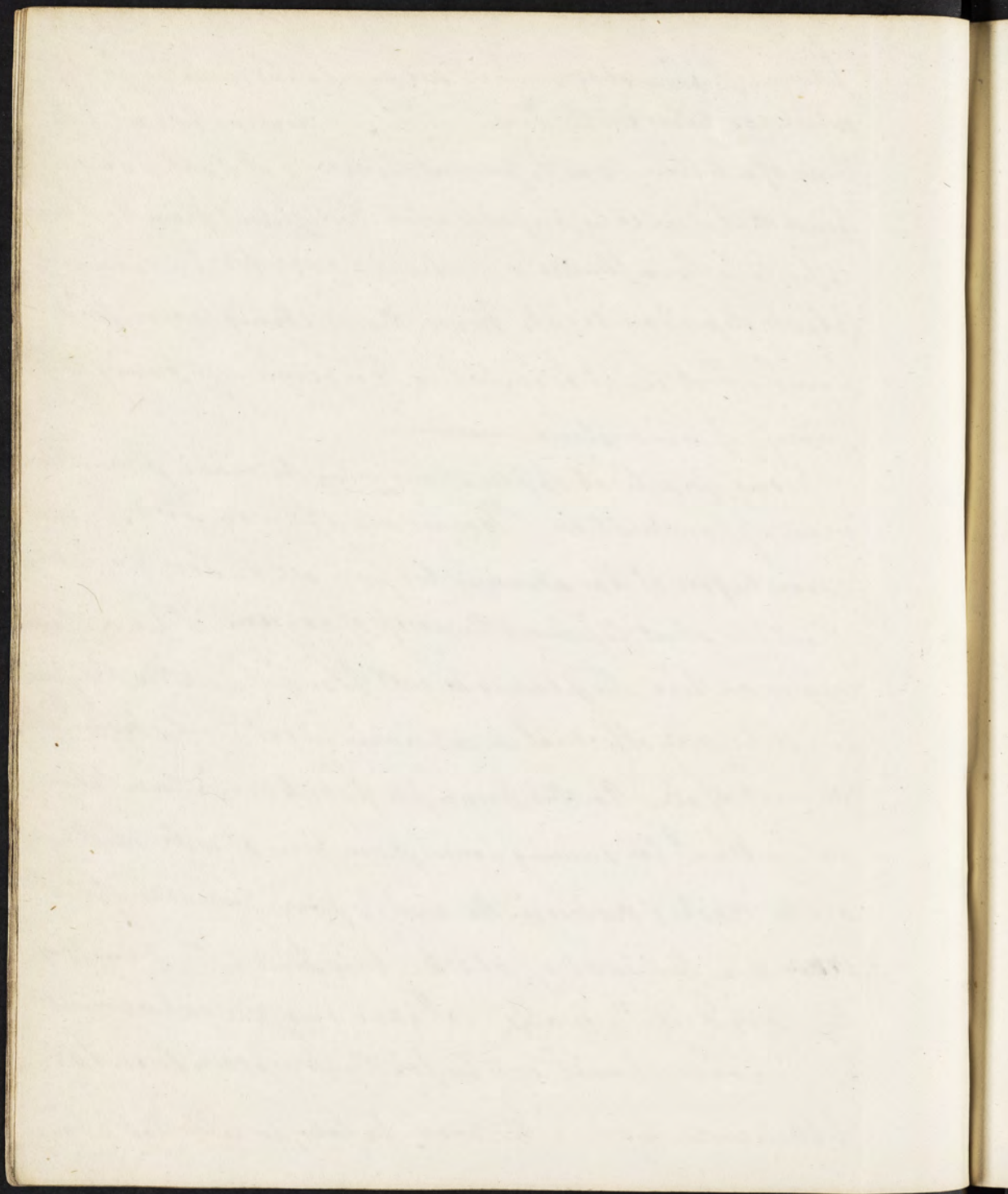


-gen will be 4. & hydrogen will be 21. I will now suppose that the more rare & lighter a body is - the more heat will it hold permanently combined. A certain quantity of heat is necessary to change ice into water - & a quantity indicated by 140° of ^{the} thermometer - yet the temperature of the water is not increased by this, but remains at 32° the temperature of the ice. What becomes then of this 140° degrees of heat? It must have entered into chemical combination with the ice. In like manner when the gases are converted into water, the heat which is combined with them as gases, is evolved. When I set fire to dry shavings, what do I do? I enable the oxygen of the air to combine with the shavings - these consist of hydrogen & carbon chiefly; both combustible substances, the oxygen therefore uniting with these combustibles is condensed - I must give out the caloric, which was necessary for its existence as a gas. Such is the theory of Combustion; Hence the fire, flame &c occur only when the combustion is very rapid. As to light & flame I shall have to say more when speaking of light. At



present I may observe that all vegetables imbibe light, which combines with them. This is evident by tying up the head of a lettuce, so as to prevent the access of light - you will find that it will be perfectly white & different from the leaves exposed to the influence of the light & air. All the colours of plants depend on light. Hence there is strong reason for believing that light is imbibed & is given out during the process of combustion.

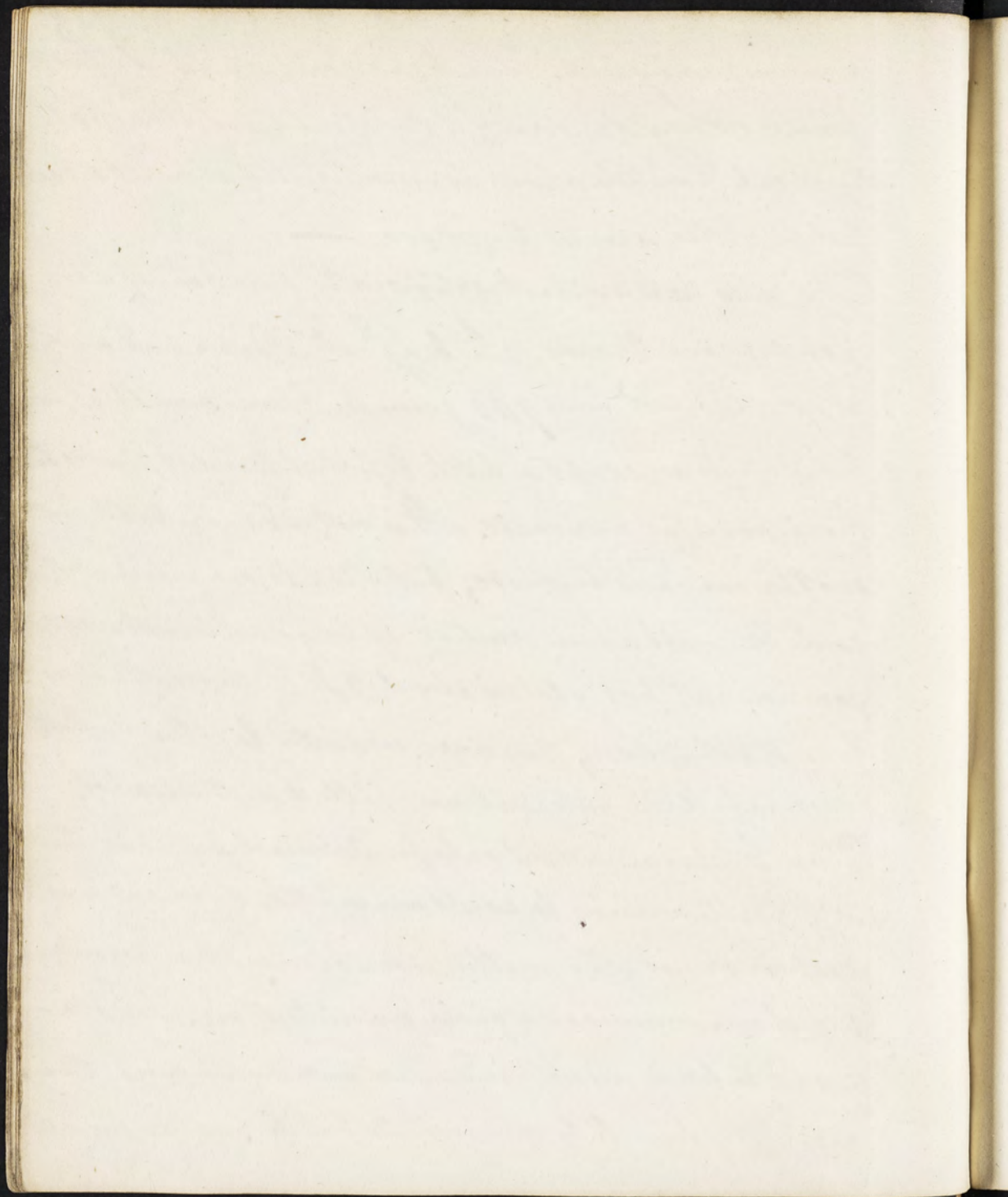
Some practical applications may be made from this view of Combustion - Houses are often on fire: in such cases - before it has advanced too far - all the doors & windows should be shut to prevent the access of oxygen. When a chimney is on fire the placing of wet blanket over the fire place will be very effectual in extinguishing it by destroying the current of air. On this principle patents have been taken out in Eng^d for securing houses from fire - it is by shutting up all the cracks & crevices in the walls & floors by means of putty or a thin coat of plaster - laid under the boards of the floor & in the walls - I have seen the experiment in a wooden house erected for the purpose - two tar-barrels were fired in the room below, while that above



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remained uninjured. The light combustible dresses of females are very dangerous, if they should catch fire - a horizontal position should be immediately chosen & a carpet be rolled around the person —

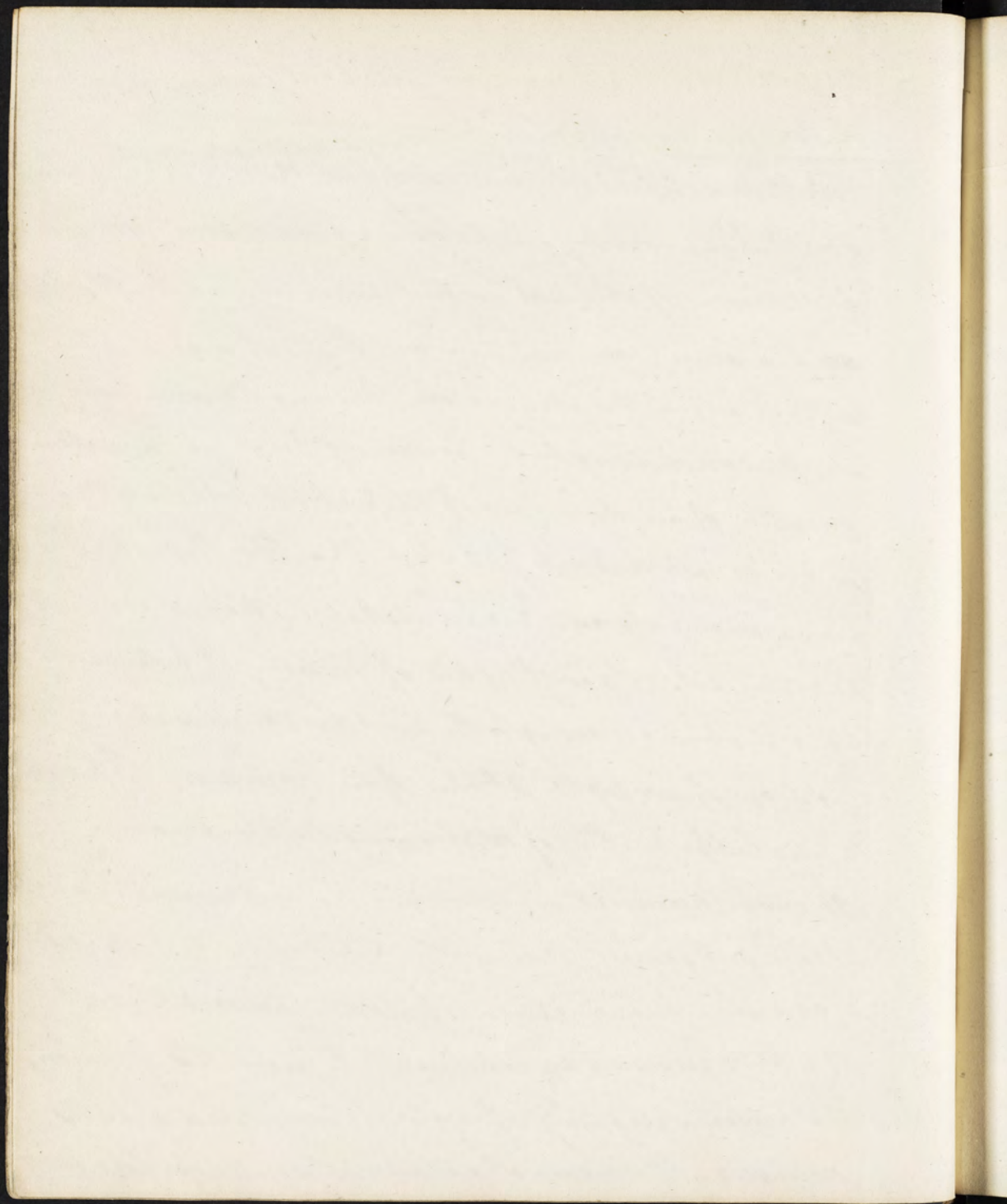
We also produce heat artificially by means of Lens & of concave Mirrors. In Eng^d - Mr Parker had one of glass which cost him 700 guineas. It was very large, solid & uniform except a little defect at the edge, & was the most powerful ever made. It is not indeed probable that another one could be made; but there is one which I think could be made again - instead of being solid - it was composed of two glasses about 2 ft in diameter & made like Watch Glasses, these were cemented together by their edges - while the interval was filled with alcohol. These Glasses are useful only for Optical purposes, thus Dr Priestly wishing to ascertain whether diam. ond was carbon or not, he melted some diamond powder in a vessel over mercury in a given quantity of air. The diamond entirely disappeared - There were no remains - the air was not found to be diminished - but to be changed into



carbonic Acid. There are no practical purposes to which
the lens can be applied.

Heat is artificially produced by Frictions. If a black
smith hammer very quickly on a piece of iron, the iron
will become of red heat, so that a match can be lighted.
~~the~~ This arises from compression. The heat is as it were
pressed out of the atmosphere. Precisely the same way, as
in the condensing tubes for firing steam - a certain
quantity of air - by means of the piston is suddenly & ra-
pidly compressed into $\frac{1}{20}$ its bulk. It is thus changed
from a ~~rare~~ ^{rarer} into a ^{denser} ~~rarer~~ substance. & of course heat
is given out. So in the case of friction, I believe the
heat produced is owing to the sudden condensation of
portions of air by the strokes of the hammer. I know
of no better method of explaining the phenomena.

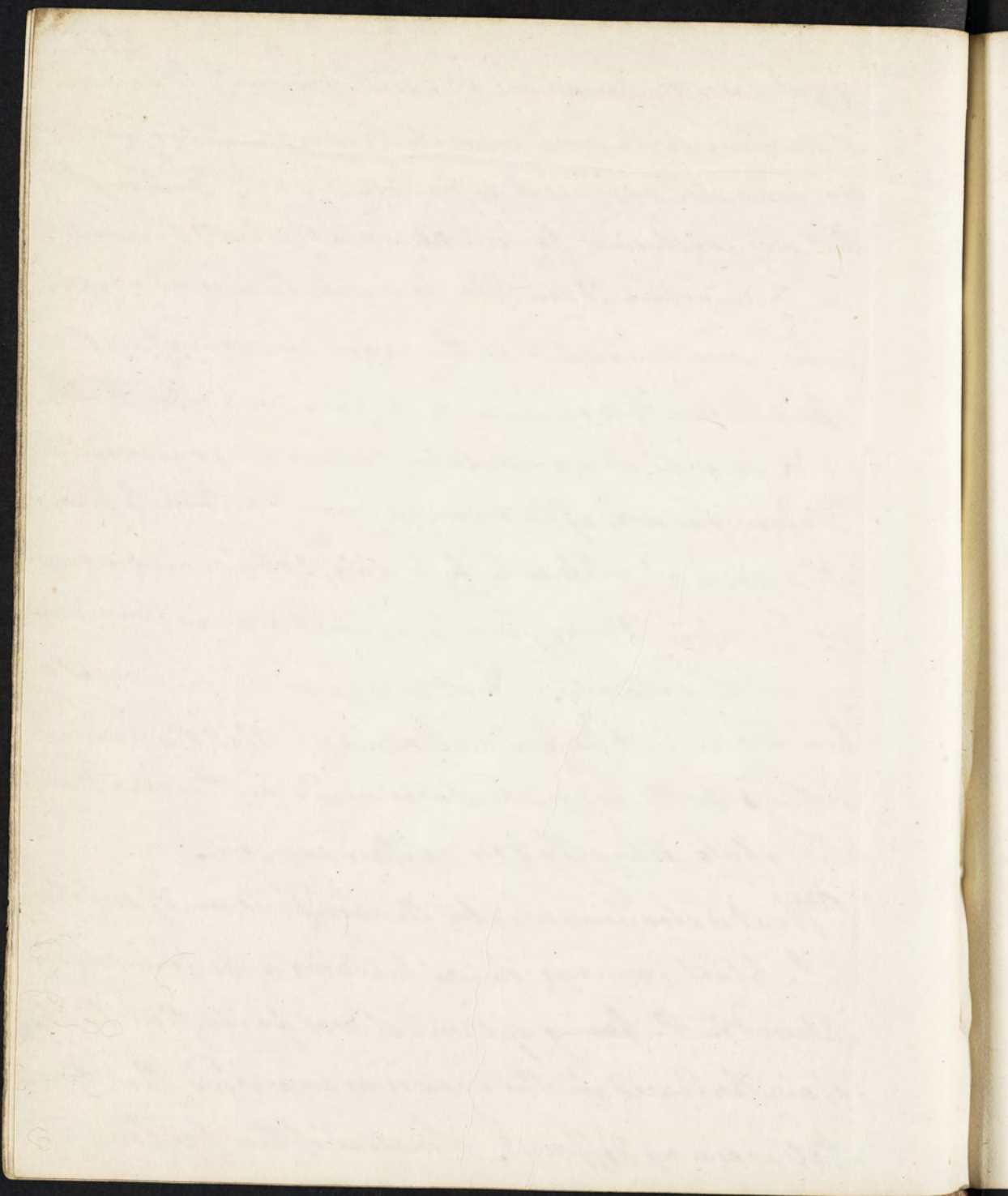
Count Rumford, who thought that heat was not a sub-
stance "sui generis," but with Newton & others, that it
was a mere modification of motion among the particles
of a body, invented an experiment to prove this opinion.
In a given quantity of water he immersed a brass
cylinder. By means of a water wheel, he pressed with



great force the blunt end of a steel piston - & thus caused it to move with such velocity that a quantity of heat was generated sufficient to boil the water. He thought that was conclusive, for where does the heat, there is no air from which it could be procured, there is no oxygen which was supposed to be the grand reservoir of heat.

He appears to me however to have forgotten that the water as well as air contains caloric in combination. Wedgewood was of the same opinion & he took to prove it - a piece of glass which, he said, contained no oxygen & pressed it very firmly against a grindstone turning with velocity. Heat was produced in a great abundance - but he did not consider that this proved nothing - as the experiment was made in the air - & also as the glass actually does contain oxygen.

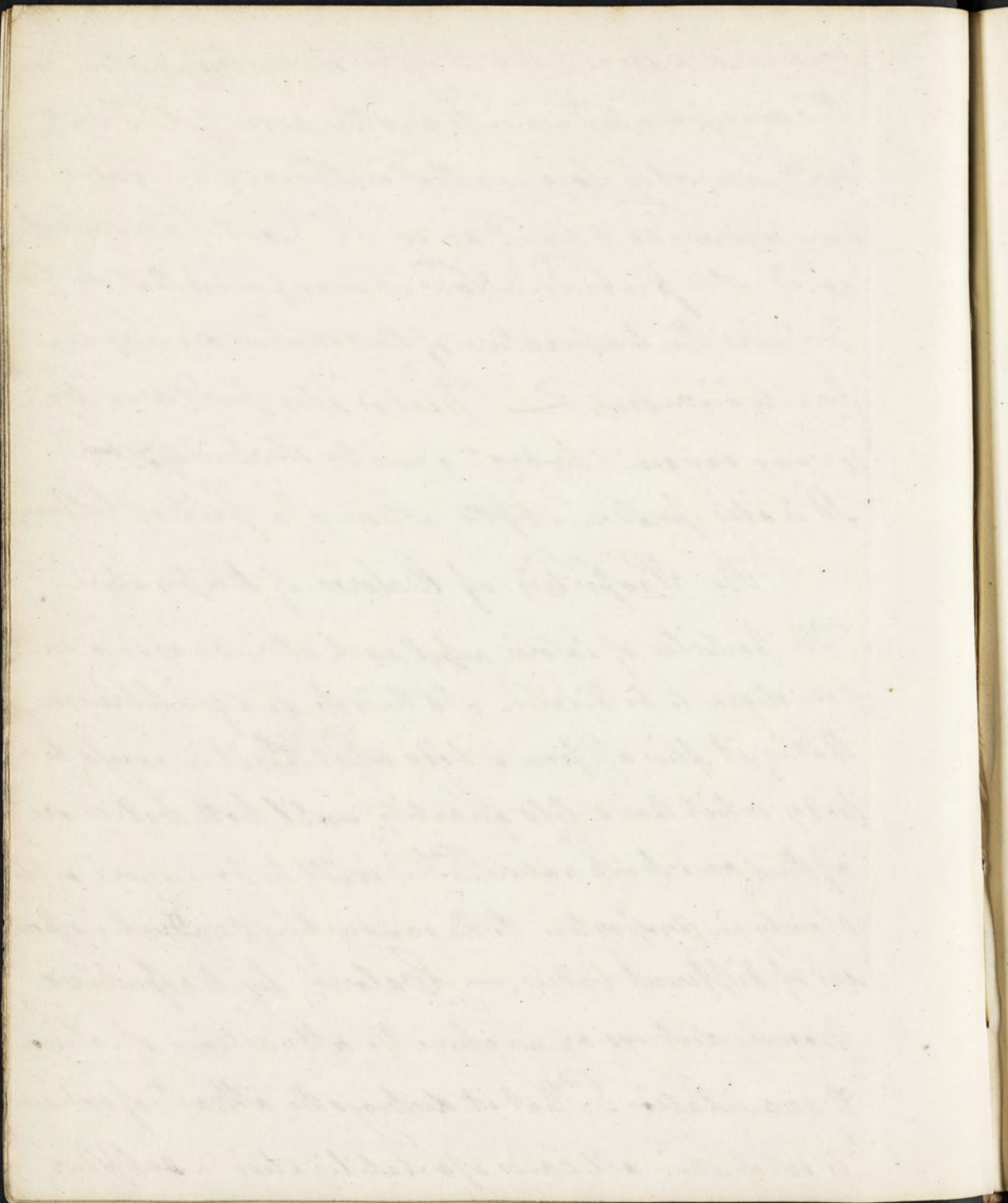
Heat is also produced by the compression of substances. In blast furnaces where bellows were formerly employed in the fusing of iron - it was found that the strain of air produced in this way was so varied, that the metal was very different. Instead of the bellows they



condensed a large body of water in a strong stone room
 this was pumped up into another room filled with
 air & perfectly close - so that in this way a regular pres-
 sure was made & by it an equal blast of air could be
 constantly produced. Now it was found that by the
 pressure the temperature of the confined air was consi-
 derably increased. — Heat is also produced by
 firing oxygen & hydro^g gases by electricity. ~~by~~
 It is also produced by the action of a pair of bellows.

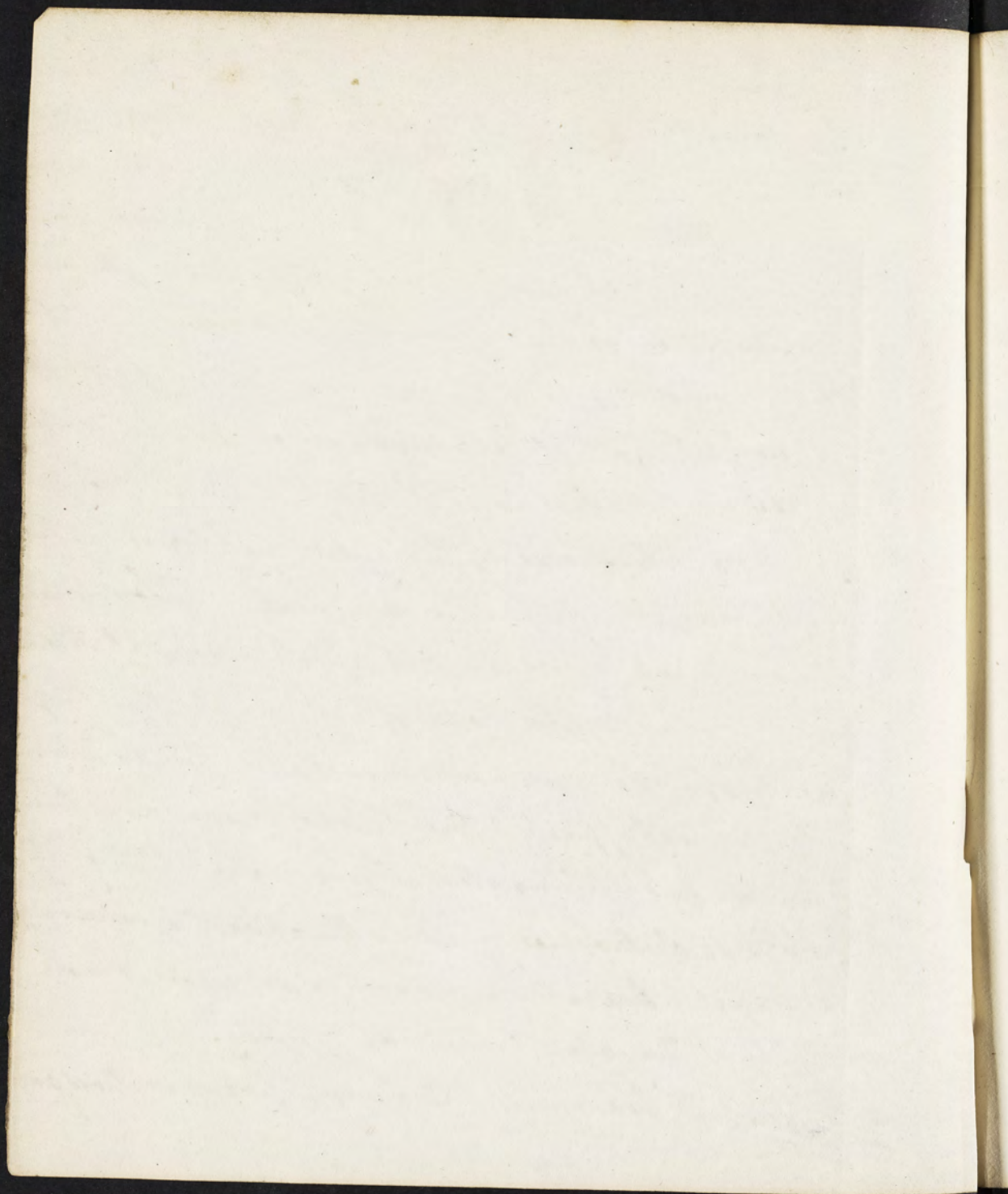
The Properties of Caloric of temperature

The particles of caloric repel each other - so as in a cer-
 tain degree to be dilated. It tends to an equilibrium -
 that is, it flies off from a body which has it in excess to a
 body which has a less quantity - until both bodies are
 of the same temperature. This will be done more or less
 slowly in proportion to the conducting & radiating pow-
 ers of different bodies. — Caloric, by its repulsive
 power destroys or weakens the attractions of cohesion
 & gravitation. That it destroys the attractⁿ of cohesion
 is evident in all cases of volatilization - sulphur,

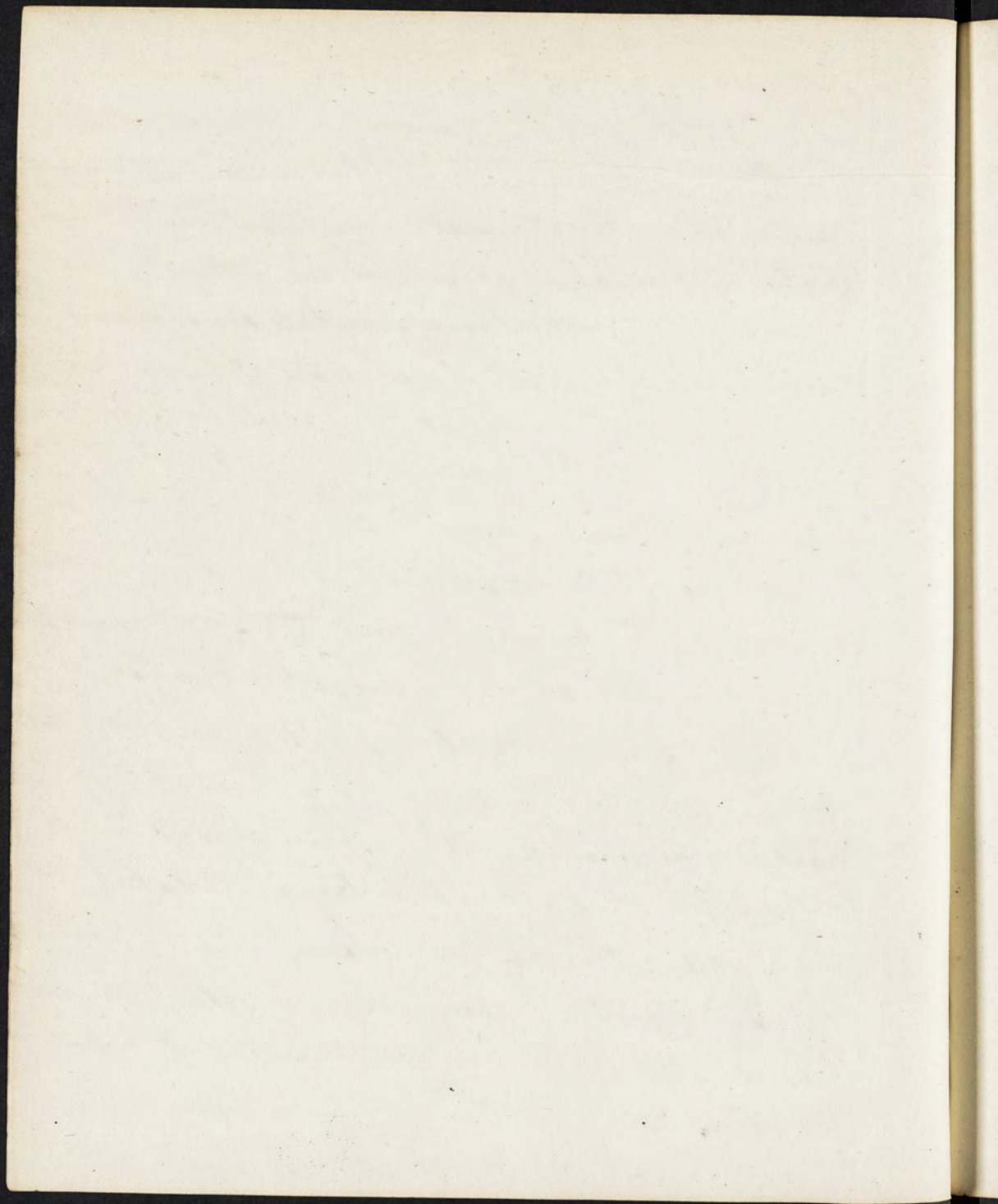


benzoin camphor &c &c when exposed to heat alone have their form destroyed the attⁿ of aggregation is overcome & they appear in the finest powder. In this case also we see that the attracⁿ of gravit^y is overcome by caloric for the sulphur, camphor, &c immediately rise in the air in opposition to gravity. That it overcomes these attractions is evident also in the common method of distilling alcohol: In fact all attractions are overcome by caloric & as much so, that some Philosoph^{ers} have supposed, that caloric is the source of the centrifugal force: but this is established by no facts or arguments. Sometimes it counteracts & sometimes it assists Chemical Affinity. When the repulsive power of heat is greater than the affinity of two or more bodies to each other, these are separated - Chemical affinity is counteracted, is overcome. This is the case in distilling alcohol from water - But when caloric so destroys - or weakens the attracⁿ of cohesion ^{in a body} as to enable ~~the~~ another substance to act upon it more easily - it then assists chemical affinity.

Heat is transmitted thro' some bodies without any



interruption as thro' the air & gases. Altho' it differs, its pas-
 sage is interrupted & it proceeds more slowly - it is then
 said to be conducted. Some bodies conduct heat bet-
 ter than others - thus charcoal conducts heat very badly - a
 portion of charcoal may be red-hot - while the opposite
 end may be held without injury: metals are good conduc-
 tors of caloric if one end of a piece of metal be heated, the
 heat will quickly be evident at the opposite end. Hence in
 winter we employ bad conductors of heat for our cloth-
 ing - as wool & silk. Hence in cold countries they have
 double sashes to their windows, that a plate of air may be
 interposed which is a very bad conductor. By some bo-
 dies heat is interrupted in its progress & absorbed, as by
 those which have an attraction for it: by some it is not
 interrupted. Altho' in the focus of a lens, both heat &
 light are concentrated - yet if a piece of glass be held
 before a fire - the light will be transmitted - but the
 heat will be retained. Caloric is reflected by some bo-
 dies - as by concave metallic mirrors - a silver spoon with
 polished will reflect a considerable quantity of heat -
 It is true, that I have been lecturing as if there were no



doubt of the chemical theory, that heat is a substance;
 & Newton Hope, Davy & many others deny this - I maintain
 that heat is merely a motion among the particles of a body.
 This may be true - but if true, I cannot lecture - I must
suppose that it is something - before I can tell you any-
 thing about it. Hold a table spoon to a heated body
 & I find that heat is concentrated: now what is concentra-
 ted? Is it motion? - motion is the property of something
 there is no motion unless there be something to be moved,
 What then is moved? The air - but the air is always in
 motion - & yet no heat is produced - besides I do not know
 that air can be reflected - & refracted - In lecturing to
 you therefore I must consider heat as a substance
 so that I may be able to describe its properties -

Heat is radiated by some bodies - passing off from
 them in radii - or lines from a centre. Of this more pre-
 sently. - When heat is not accumulated in large
 quantities - & where it remains for a short time - it pro-
 duces no chemical change - on bodies, which reflect
 conduct transmit or absorb it. Heat expands all

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bodies in different proportions - the expansion generally being inversely to the ~~constant~~ attraction of cohesion.

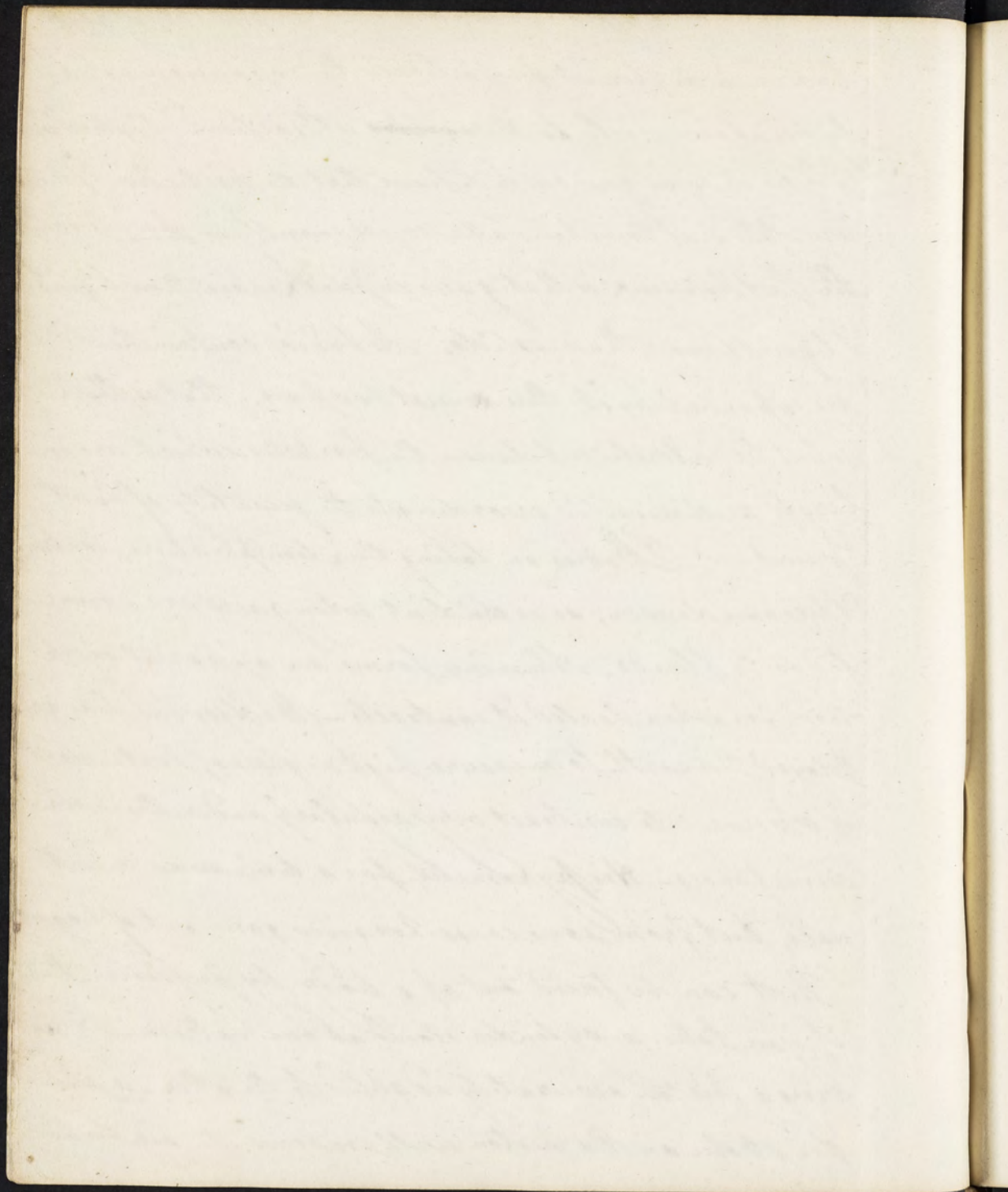
There is some reason to believe that the particles of fluids are spherical touching ^{each} other consequently in points only.

The fact however is that gases expand more than liquids & liquids more than solids. As bodies contain heat &

are expanded by it there ~~must~~ be space, - that is, there must be interstices between the particles which are enlarged or diminished according to the quantity of heat present.

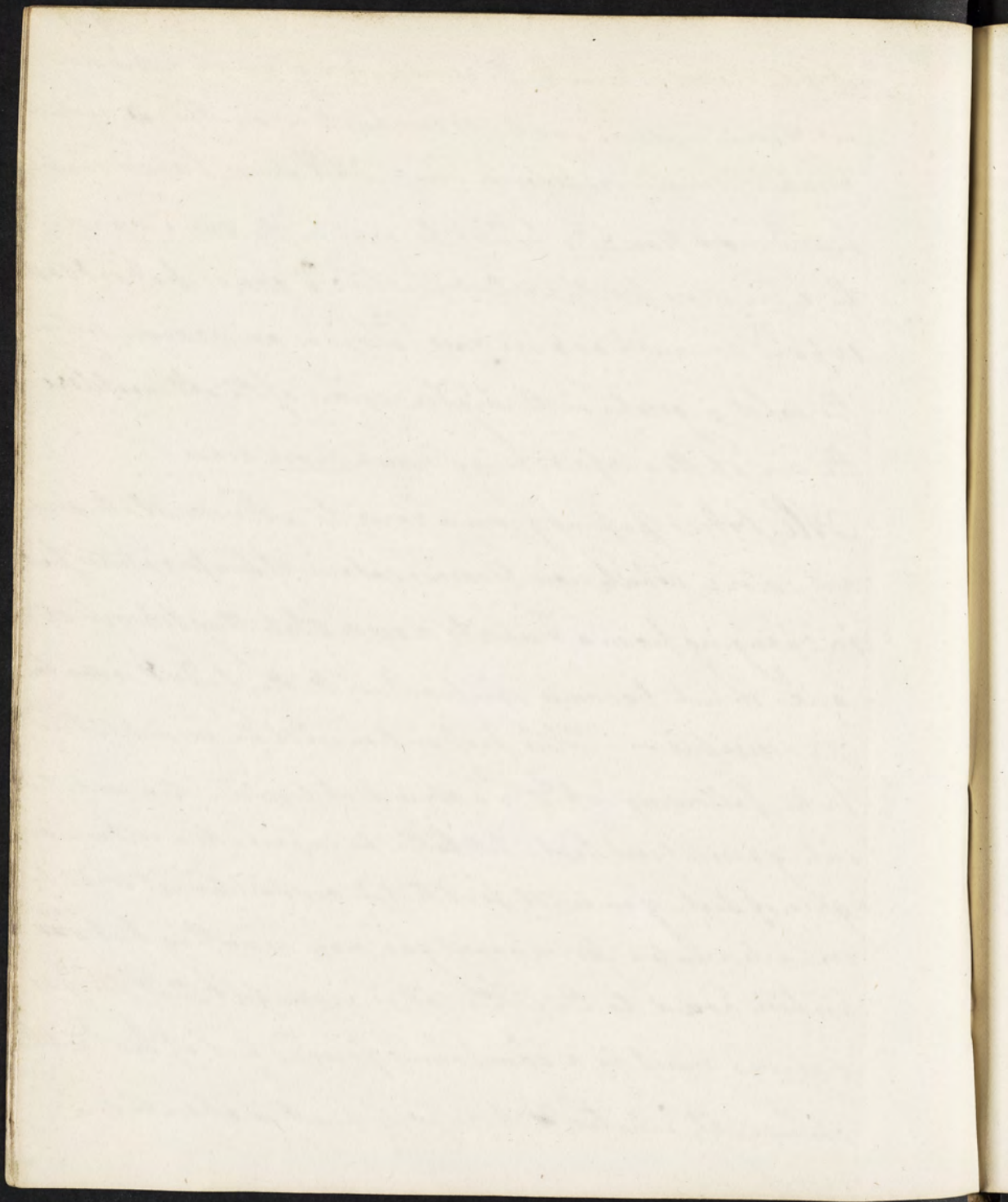
Bodies on losing their temperature, contract & become denser, as is evident when gases are converted into fluids. Alumina forms an apparent exception for when heated it contracts - Wedgewood has employed this earth to measure high degrees of heat - as it is observed to contract very regularly under these circumstances - His pyrometer for a time was much used, but from some cause has now gone out of vogue.

Heat can be forced out of a body by pressure - thus if you take a cylinder closed at one extremity & having a piston accurately adapted to the other - a sudden stroke on the piston will condense the air between

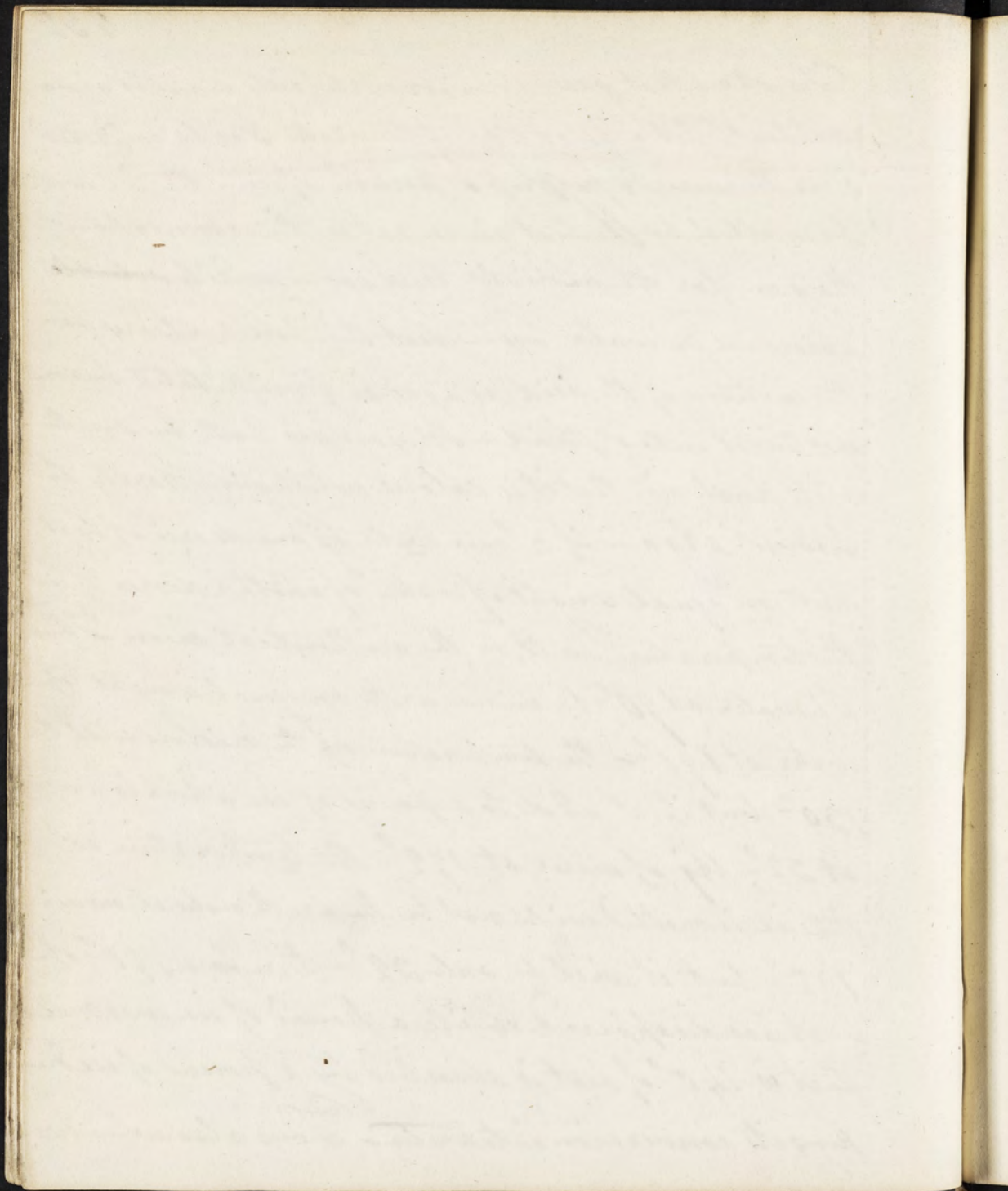


it & the closed extremity - the consequence of which heat is given out. I will inflame any light combustible matter, a piece of punk is usually employed. — All dense bodies can be heated more than rare bodies, because in the same space, there are more particles to be heated: & dense bodies do not expand so much as rare ones. This is one reason, why the cold is greater in the higher regions of the atmosphere, the air at the surface being much more dense.

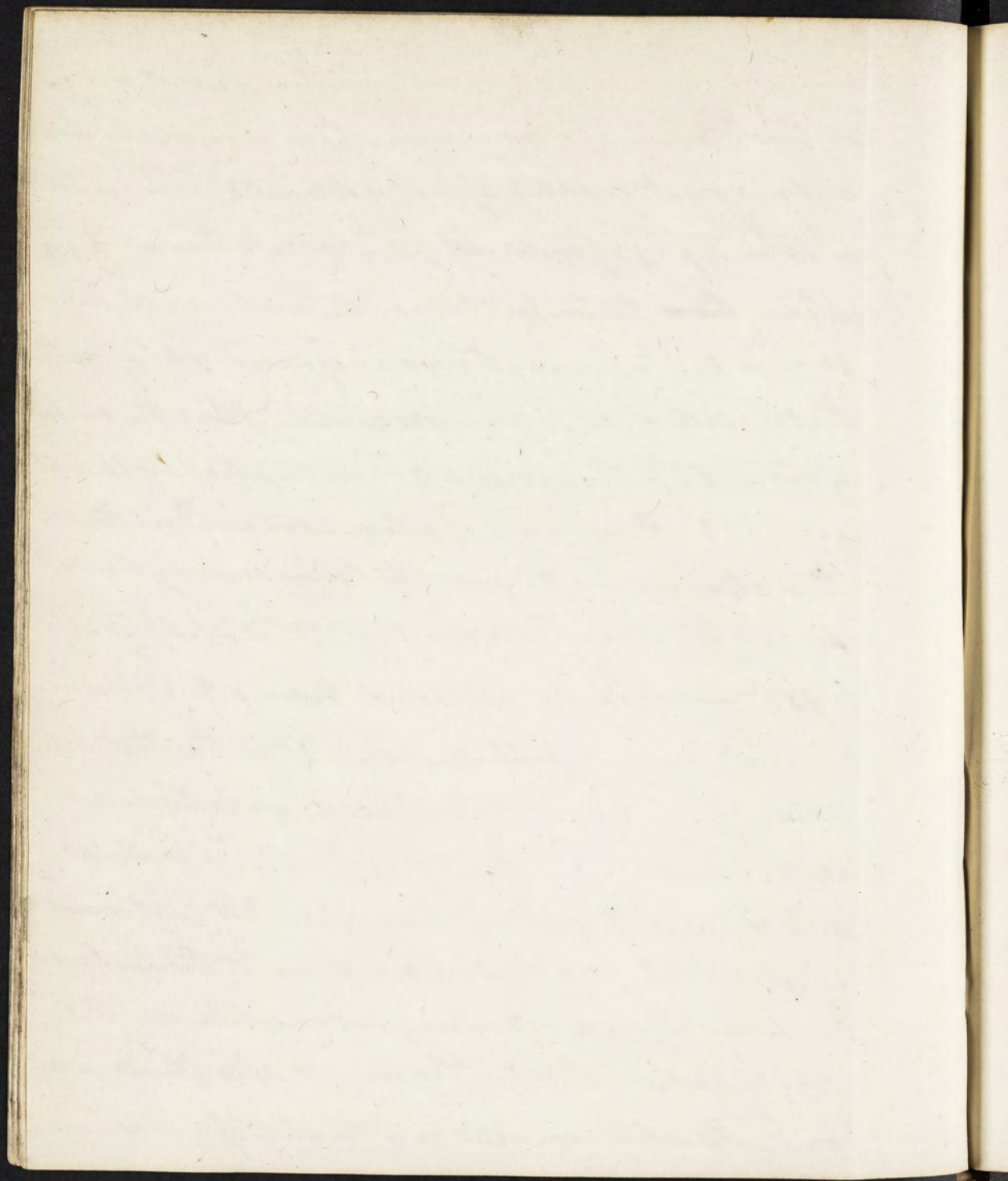
All bodies passing from a rarer to a denser state give out caloric, which now becomes caloric of temperature, heat in changing from a denser to a rarer state they absorb caloric - which becomes combined with the body & is no longer sensible — This proposition will be exemplified by the following exp^t. To show that liquids when converted into gases absorb heat. Let Ether be exposed to a certain degree of heat - you will find that in a short time it will be converted into a permanent gas - now as nothing but ^{heat} ~~gas~~ has been added to the ether, it is manifest that the gas produced must be a compound formed out of heat & ether chemically united & therefore heat is absorbed —



To show that gases when converted into liquids give out heat. Let a quantity of Muriatic Gas be collected over mercury - & pass up a portion of ice - the ice will be melted by the heat given out by the condensation of the gas - For the muriatic acid gas is readily soluble absorbed by water - The heat therefore necessary for the existence of the acid as a gas is precipitated by converting it into a fluid - so you see both by synthesis & analysis - that it is caloric which gives rarity to bodies. Again if I mix water of one degree of heat with an equal weight of water of another degree of heat the temperature will be the arithmetical mean. Thus if water at 70° be mixed with an equal weight of water at 130° - the temperature of the mixture will be 100° - but if I add to a pound of ice which is always at 32° ; lbj of water at 172° - the temperature when the ice is melted will not be the arithmetical mean 102° - but it will be only 32° - therefore 140° of heat has disappeared - while a pound of ice was melted that is 140° of heat is absorbed by a pound of ice during its conversion into water - Thus also when wa-

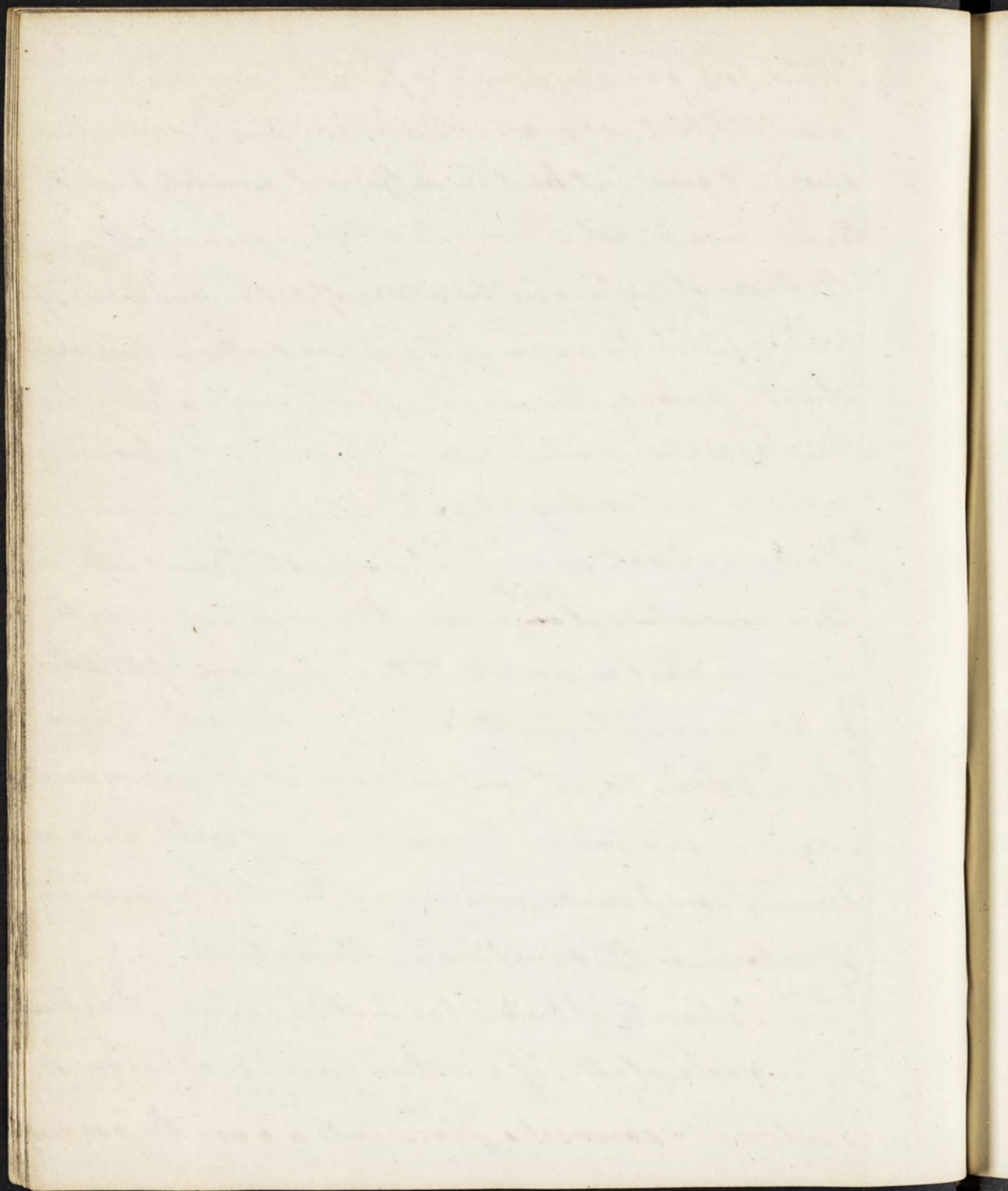


ter is converted into steam a quantity of heat is ab-
 sorbed. & on the contrary when steam is converted into
 water a great quantity of heat is extricated. Thus If
 I take 32 vi of water at 70° & pass thro' it 314
 steam, ~~the~~ the temperature of the water will be
 raised to 122° - having therefore acquired 52° of heat.
 that is - each of the 16 parts has received from the one part
 of steam - 52° - therefore 52° multiplied by 16 will
 give 832° - the quantity of caloric contained in the steam.
 This, allowing for the quantity taken away by the re-
 -sel air &c - is very near what Mr Watt stated - 900°
 to 950° - Hence all solids during their conver-
 sion into liquids produce cold - It is thus that arti-
 -ficial cold is frequently produced; with this view
 ice & salt are mixed together - when the ice melts - so
 as to dissolve the salt - it is necessary that heat ~~must~~
 be absorbed before the salt will melt - this heat must
 be furnished by surrounding bodies which are there-
 fore rendered cold & are frozen - so also fluids pro-
 duce cold - when converted into the state of a Gas -



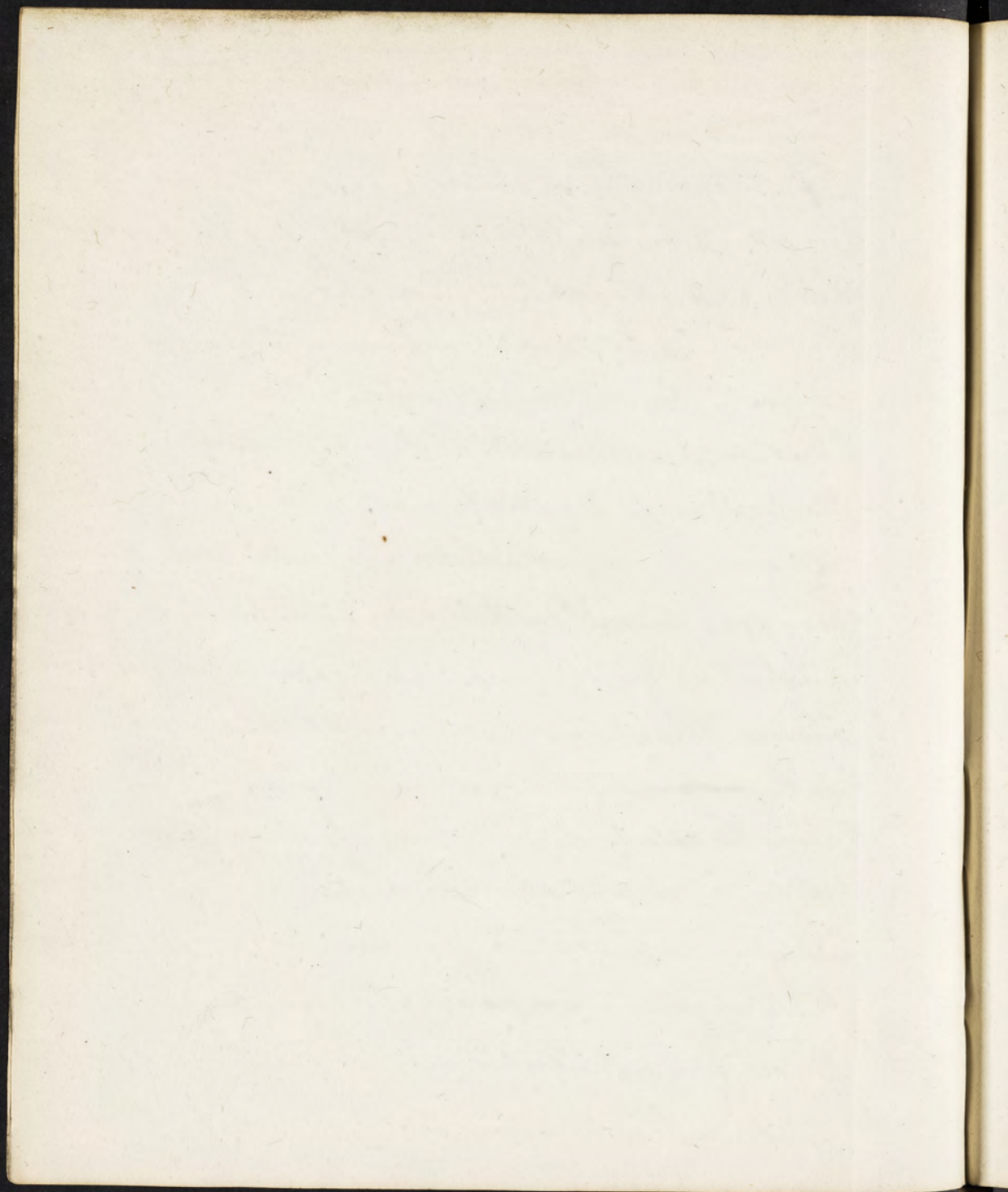
Wherefore gases, vapours, & fluids, being condensed, give out heat. as muriatic acid gas, mixed with air is absorbed & gives out heat in sufficient quantity to melt the ice immediately. From these facts & principles arose the theory of making ice by means of saline mixtures: of cooling fluids by means of Egyptian coolers, which are slightly porous - allowing the fluid to exude slowly by the evaporation of which cold is produced. So also ice is made by evaporating ether: the ether should be good, that it may evaporate speedily - it is separated from Sulphuric acid by washing it ^{with} water - the quantity of water to be frozen must be small - & the evaporation of the ether be hastened by placing the whole "in vacuo". Hence dense bodies do not contain & do not require so much caloric as rare bodies. Hence density & rarity are mere terms of comparison, expressing the relative quantity of caloric in the substances alluded to -

The Capacity of bodies for heat depends on their denser or rarer state: if a certain quantity of caloric is necessary to convert a fluid into a gas - the gas may

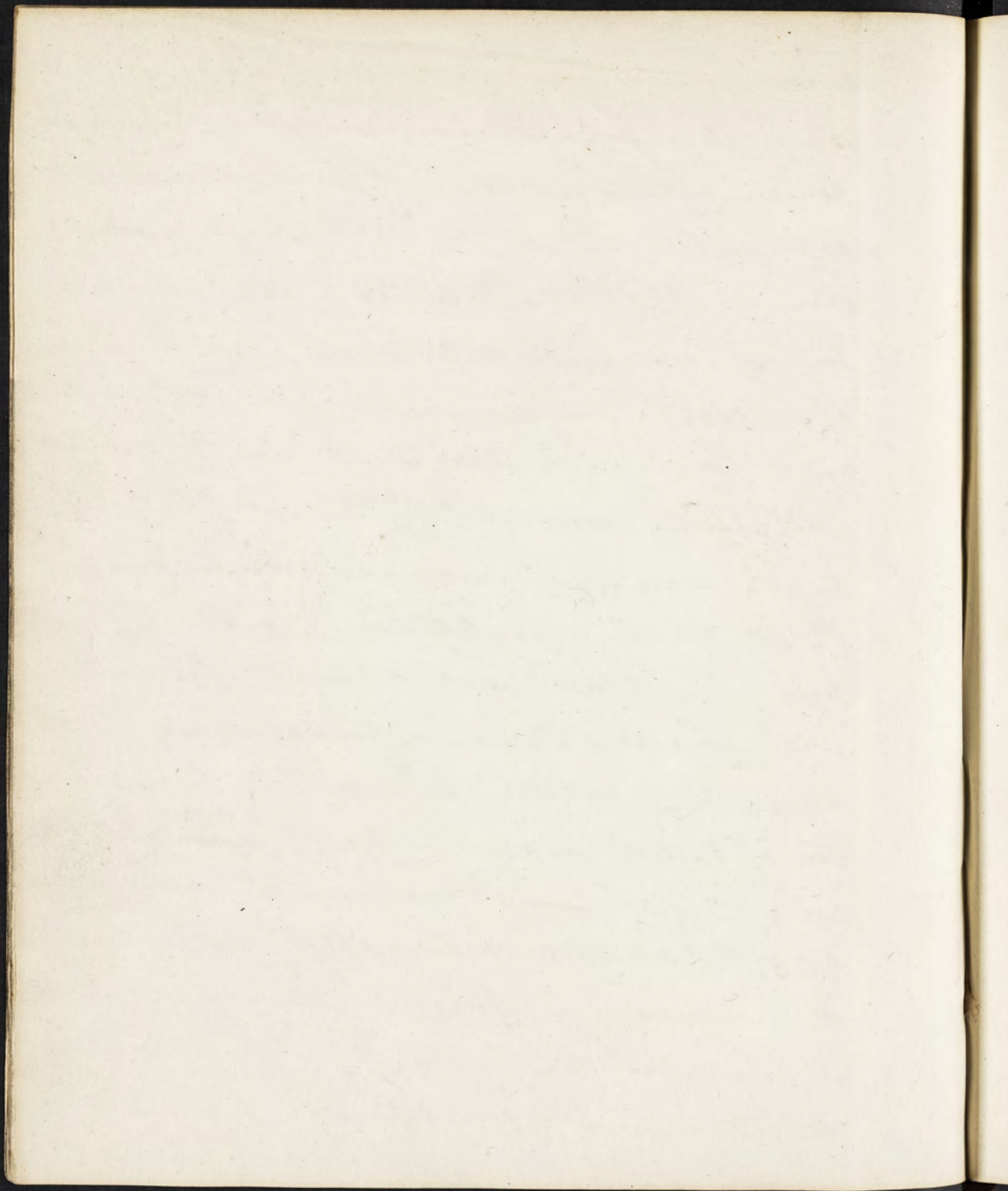


have a greater affinity for caloric than the fluid, it contains a greater quantity.

Of the radiation of caloric; it is sent off in parallel lines from plain surfaces - obeying the same laws as light. & in a radiated ~~four~~ lines from a concave surface. The nature of the surfaces influences the radiation of caloric - according to the experiments of Leslie - polished surfaces radiate with difficulty - rough & blackened surfaces radiate much more readily. Hence all culinary vessels which are to contain liquids warm for a long time should be very bright & clean. Caloric is absorbed by surfaces which radiate perfectly. Thus in Franklin's experiments - the black cloth sank in the ~~snow~~ snow & of course absorbed more heat than any other colour. The progress of heat is not affected by a current of air - ^{Schield} Schield found that when a strong current of air was directed towards the stove the thermometer was ~~not~~ influenced equally as when the air was undisturbed - air is one thing - caloric is another - Pictet found that caloric affected the ther-



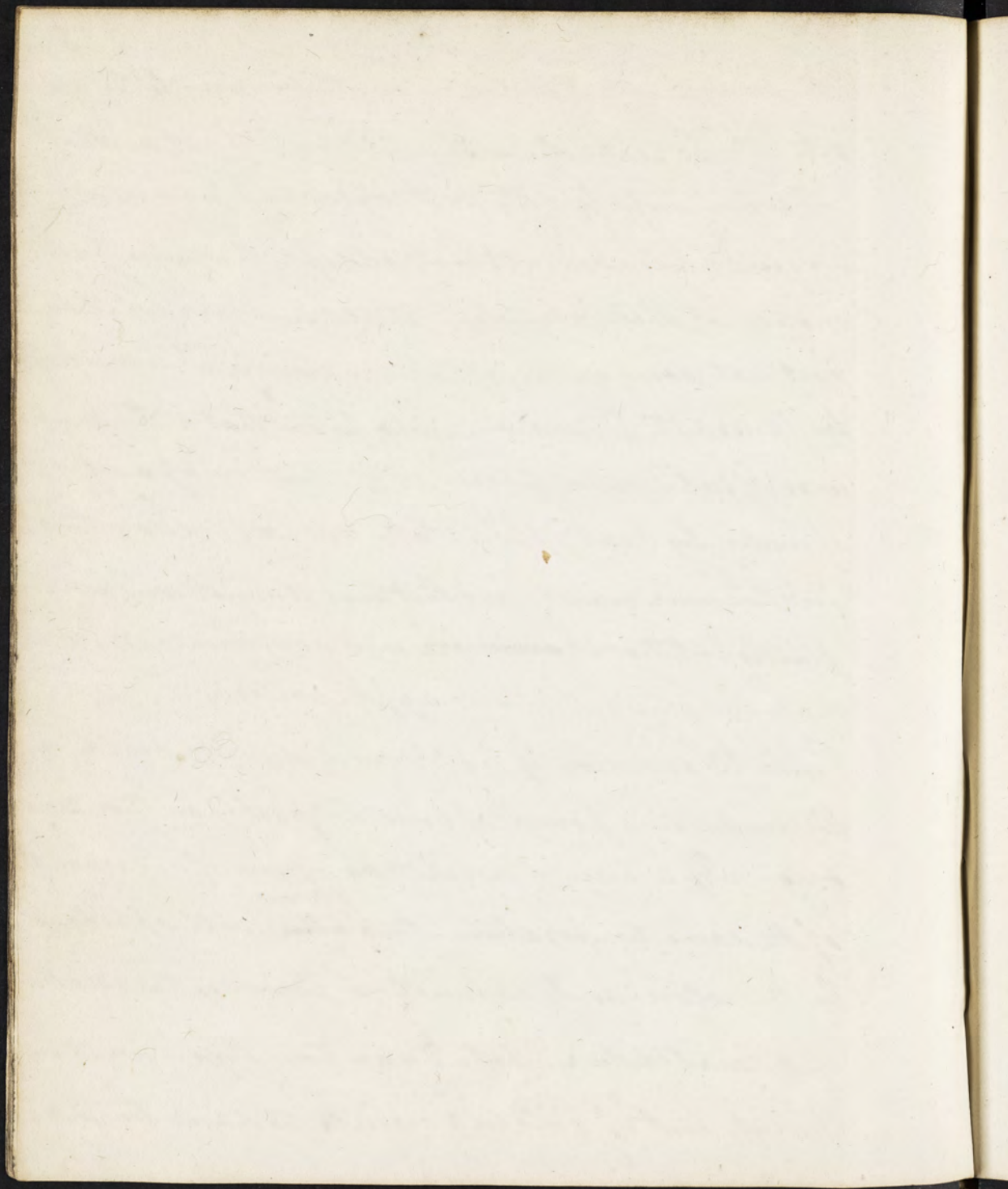
monometer instantly - at the distance of 69 ft. - Caloric
 is refracted in passing thro' bodies - It is reflected from
 concave metallic mirrors not from Glass mirrors -
 in its reflection it obeys the laws of light - as ~~far~~ was
 shown by M^r Petit - He placed a heated body in the
 focus of a concave metallic mirror - a second mirror
 of similar nature & size was placed parallel to, & front-
 ing the former - a thermometer in the focus of this last
 was affected immediately by the heat of the body in
 the other focus - which was reflected from one mirror to
 the other & again concentrated in its focus - If a cold
 body be substituted for the hot one - the thermometer
 will indicate a decrease of temperature - as if cold
 was radiated - but this is better exp^d by the supposi-
 tion of the heat being carried from the ~~caloric~~ ^{thermometer} to the
 cold substance. — It was formerly observed (page
 228) that metals were the best conductors of heat -
 this power varies in different metals some conducting
 it more readily than others - this is seen by covering
 the extremities of rods of different metals - ~~and~~ but of



the same length & diameter with be warmed at the opposite ends be heated the wax will melt first on that rod which possesses the best conducting power —

Liquids also conduct heat; chiefly however by the motion of their particles. Water however will conduct heat downwards, altho' very slowly. This was proved by Murray & Thomson who found that a thermometer was affected when placed at the bottom of a vessel of water by heat applied to the surface. Count Rumford however maintained that heat was not conducted by fluids but that it ~~came from~~ was communicated to the mass merely by the motion of the particles —

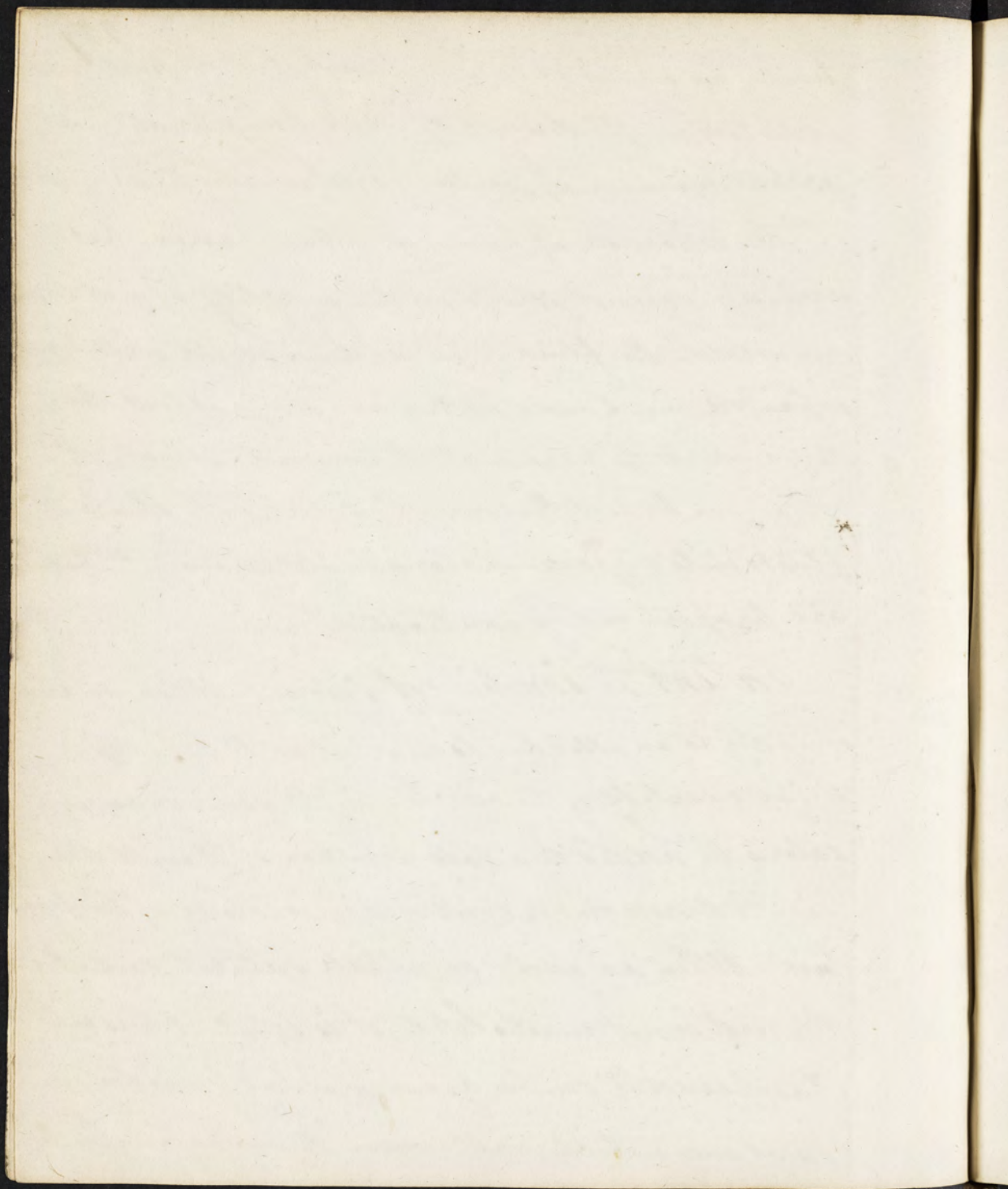
The Sensation of heat & cold depends partly on the conducting power of bodies & partly on their density. If a piece of metal & ~~a~~ a piece of charcoal be of the same temperature — the ^{former} ~~latter~~ will appear to be the colder — as its conducting power is the greatest, if a match be red hot — by an touch you will be burnt. but if gold be raised to the same tempera-



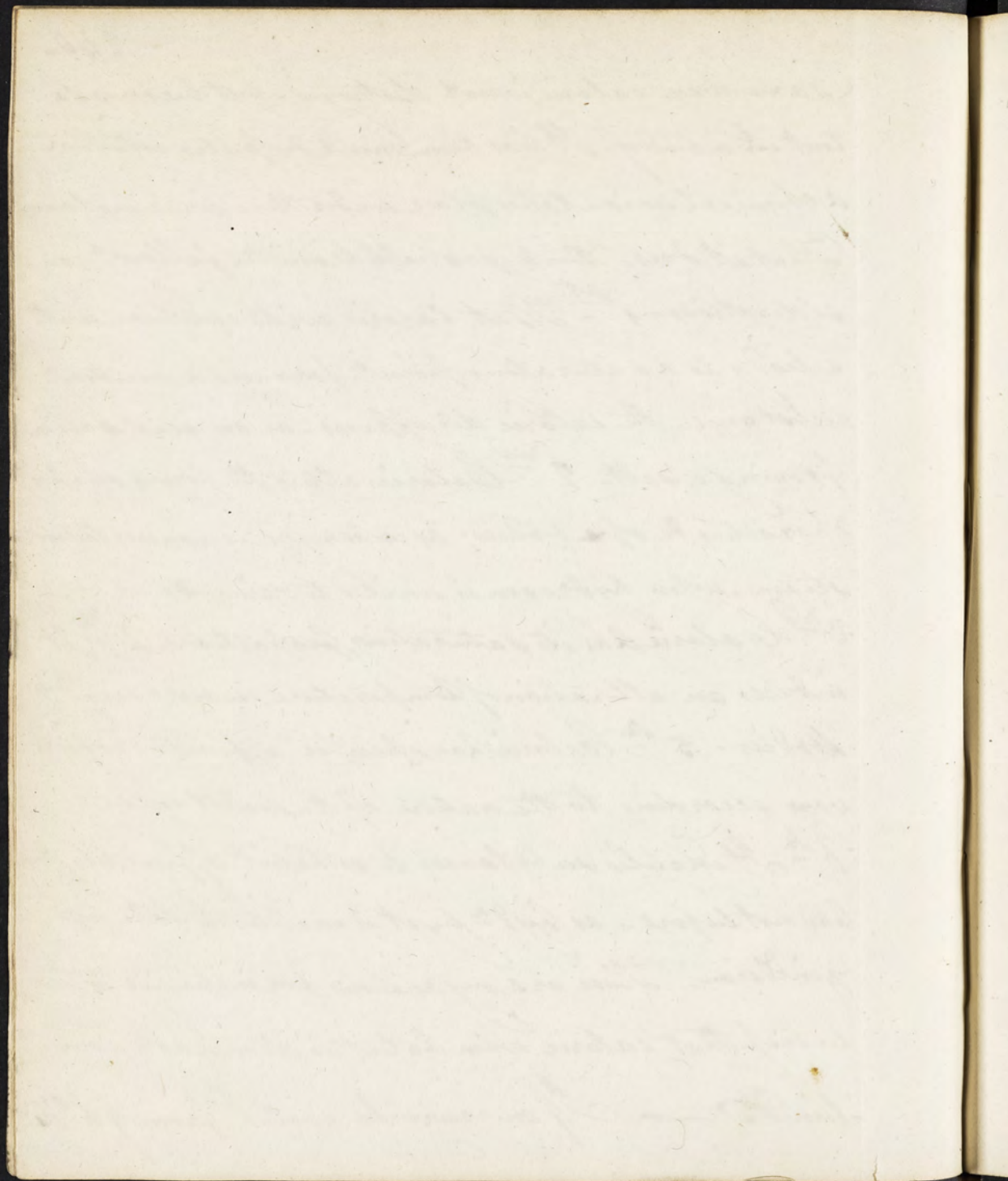
ture you will not only be burnt - but the part will be destroyed - the density of Gold being greater - a greater number of particles are heated in the same space.

The expansion of bodies when heated varies - but this variation does not depend on the quantity of heat communicated - the fluid in an air thermometer will be expanded much more by the same degree of heat than the fluid in the mercurial thermometer - It is this expansion by heat that converts solids into fluids - & fluids into vapour - caloric being removed the bodies are proportionally contracted.

Latent or Combined Caloric. When an acid is added to an alkaline liquor - it will take up a certain quantity of the alkali - in the same manner, if caloric be added to a body a portion of it will disappear - & the remainder will escape as caloric of temperature - When an acid & an alkali saturate each other the acid is not annihilated, it is latent - it has only disappeared - & can be again produced by adding any substance which will remove the alkali - In the

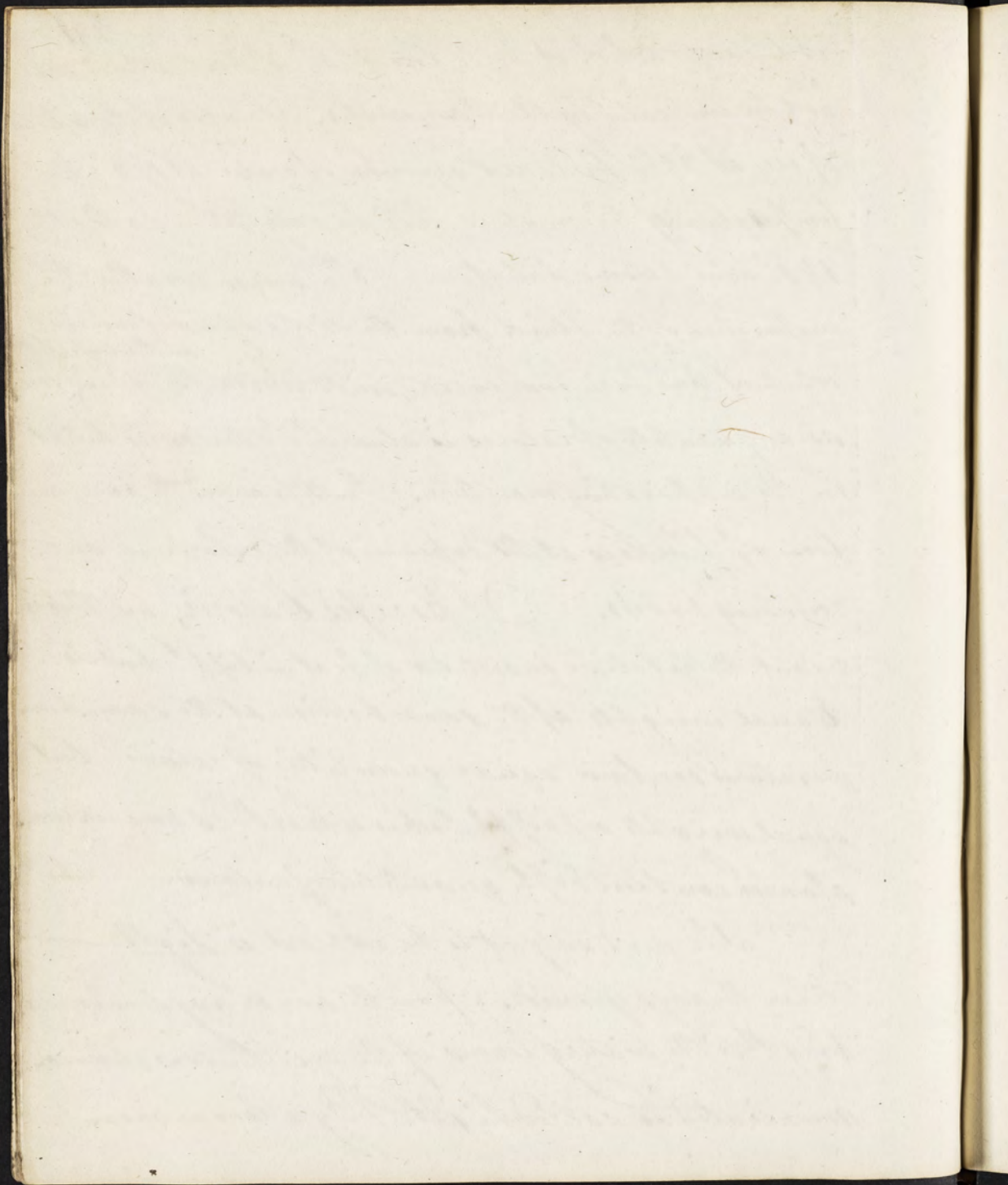


same way. caloric is not destroyed - but becomes latent in a body. It has been much disputed whether a chemical union takes place under these circumstances. That it does, I think probable from the following considerations - 1st - That caloric will combine with a body to a saturating point, forming a ^{no.} neutral substance - the caloric disappears - as an acid, does in forming a salt. 2nd - Caloric alters the forms, shapes, characters &c of ~~a~~ bodies; as when ice is converted into steam - when hydrogen is united to zinc &c - 3rd - Caloric has its saturating proportions. 4th - It induces an alteration of temperature in surrounding bodies - 5th - Caloric has specific affinities which vary according to the nature of the substances. 6th - It enables substances to exhibit affinities, they had not before - as hyd^g - by it is enabled to take up zinc &c. These are my reasons for inclining to the belief that caloric when latent is chemically combined - — If mercury be cooled from 96th to



it becomes solid it will lose 136° of heat which will not be indicated by the thermometer. So also if to a pound of ice at 32° be added a pound of water at 112° the temperature of the mixture will be only 32° so that 140 have become latent. — In warm weather the evaporation of the fluid from the sides of a vessel in which it ^{is contained} had been condensed, will render the fluid ^{in the vessel} cold as a quantity of caloric is absorbed & becomes latent in the evaporating moisture. In this way the rarefaction of fluids is at the expense of the caloric in surrounding bodies. Specific Caloric, by this is meant the relative quantities of heat in diff^t bodies — Equal weights of the same bodies — at the same temperatures contain equal quantities of caloric — but equal weights of diff^t bodies under the same circumstances contain diff^t quantities of caloric —

The next subject to be noticed is Light — When the rays proceeding from the sun or any luminous body thro' the watery lenses of the eye — the sensation communicated is called light. By a lens is meant



a solid or liquid transparent medium - convex at least on one side. The sensation produced by a ray of light thus passing thro' the lenses of the eye remains for a certain time. This time has been calculated from experiment to be $\frac{1}{400}^{\text{th}}$ part of a minute. If a coal of fire be made to revolve - instead of observing only one luminous point - a circular ring of fire will be seen. Hence the impression on the retina remains during the time that ~~the~~ is occupied in making one revolution.

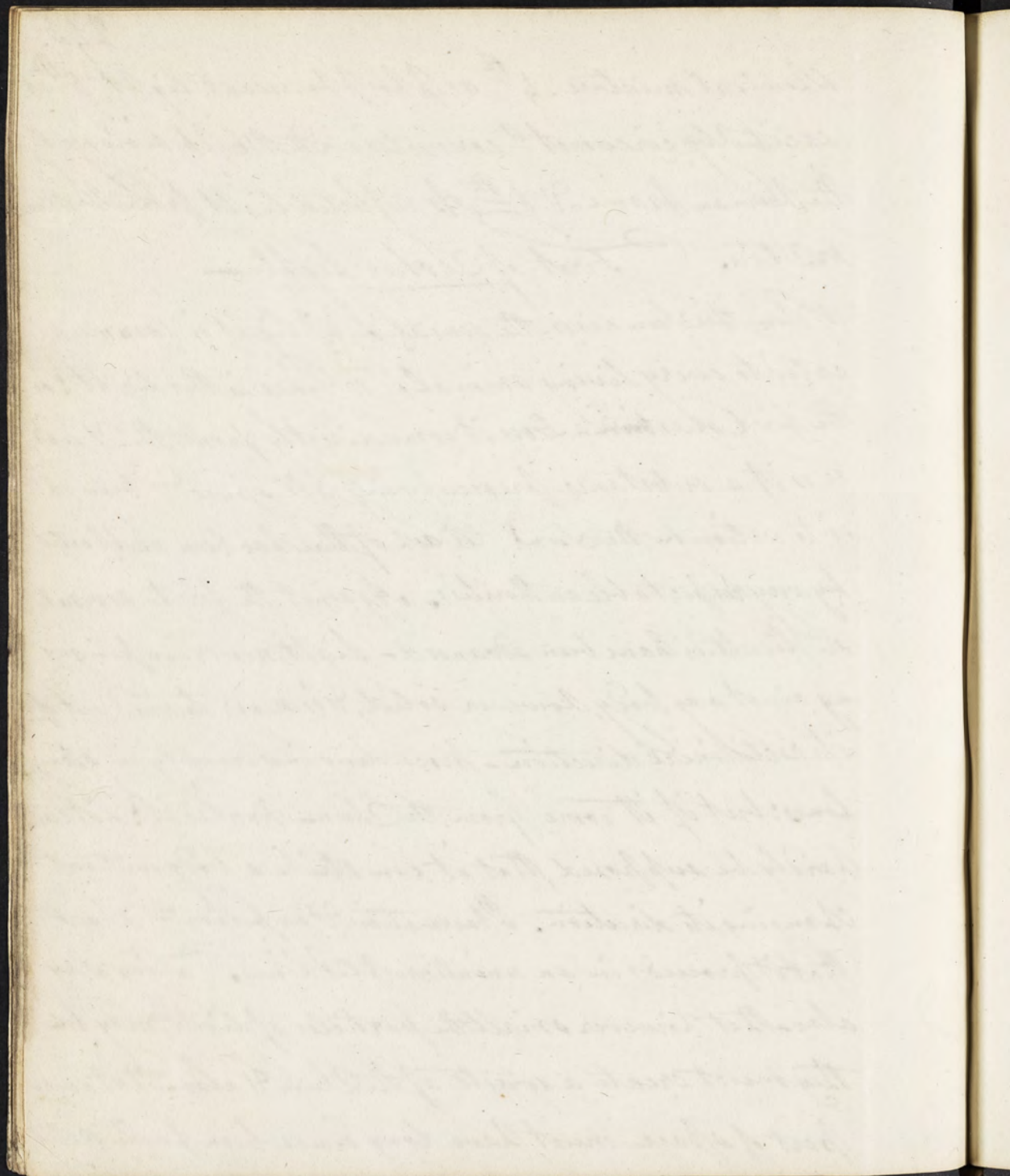
By direct calculation from this experiment of Mr. Deirect - it is proved - that the particles of light may be 26,000 miles distant from each other. Yet a continuous impression be made on the eye - As will be more fully noticed presently. This impression we are instinctively & constitutionally forced to refer to some cause - "ab extra" - something without - over which we have no controul.

Light may be noticed 1st as Solar Light, 2nd as produced by combustion - 3rd as arising from

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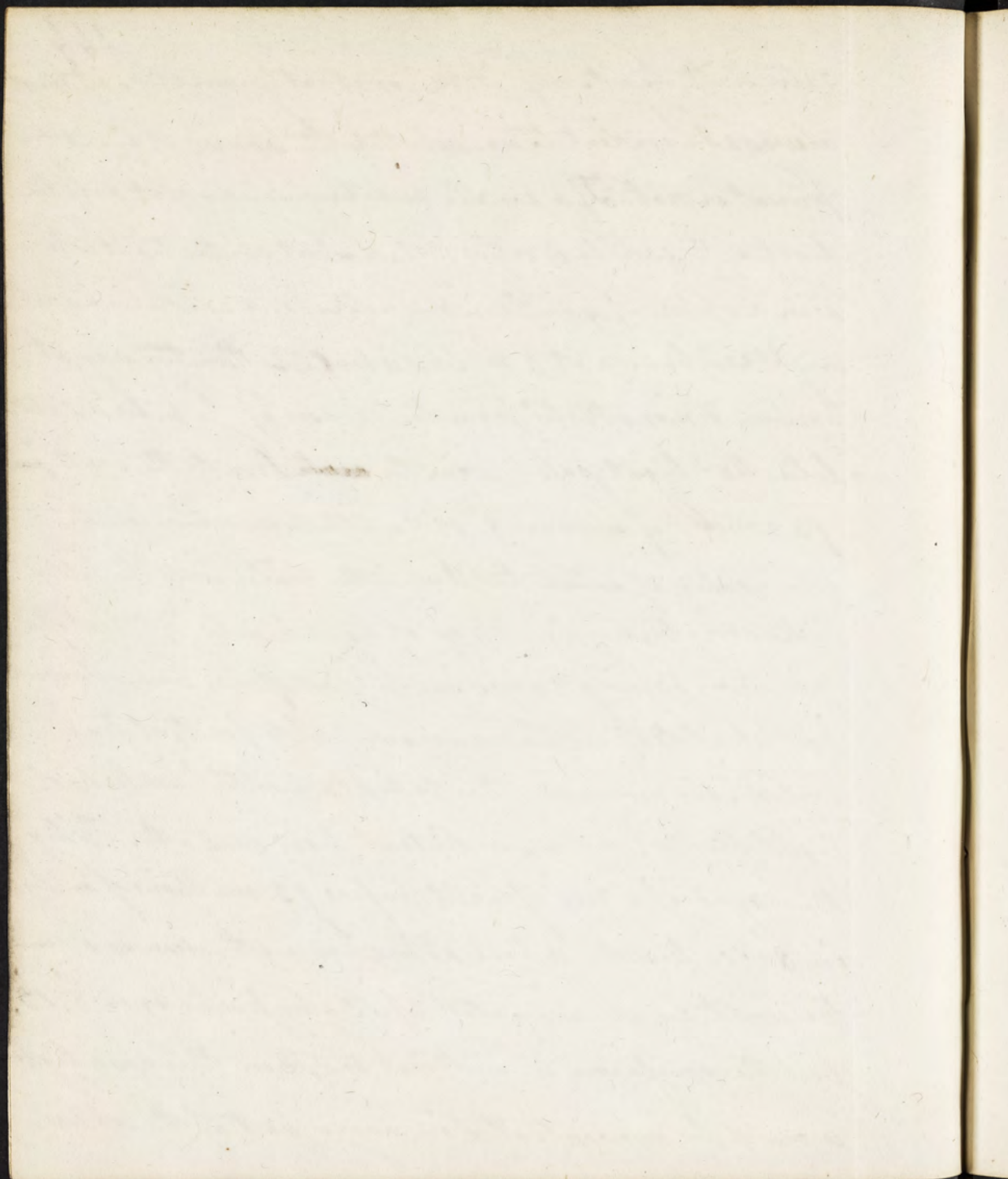
Chemical mixture. 4th as phosphorescent light, 5th as
excited by circumst^s & connected with the physiology of
the human frame. 6th as reflected light from the Moon
or Stars. First of Solar Light.—

When the Sun rises the sensation of light is communi-
cated to every living animal. Whence is this light? is
the first question. Does it come directly from the Sun,
or is it a substance pre-occupying all space & brought
into action by the Sun? Each of these has been supported
by very respectable authorities. Against the first—several
difficulties have been advanced—light never impinges
against any body, however solid, & is never turned out of
its rectilinear direction—proceeding invariably in straight
lines: but if it come from the Sun—how is it?—It can
hardly be supposed, that it can strike a body without
changing its direction. Observation & Experiment show
that it proceeds in an uninterrupted line. They say
also—that however small the particles of light may be
they must create a waste of the Sun & also—that every
part of space must have long since been fully satur-



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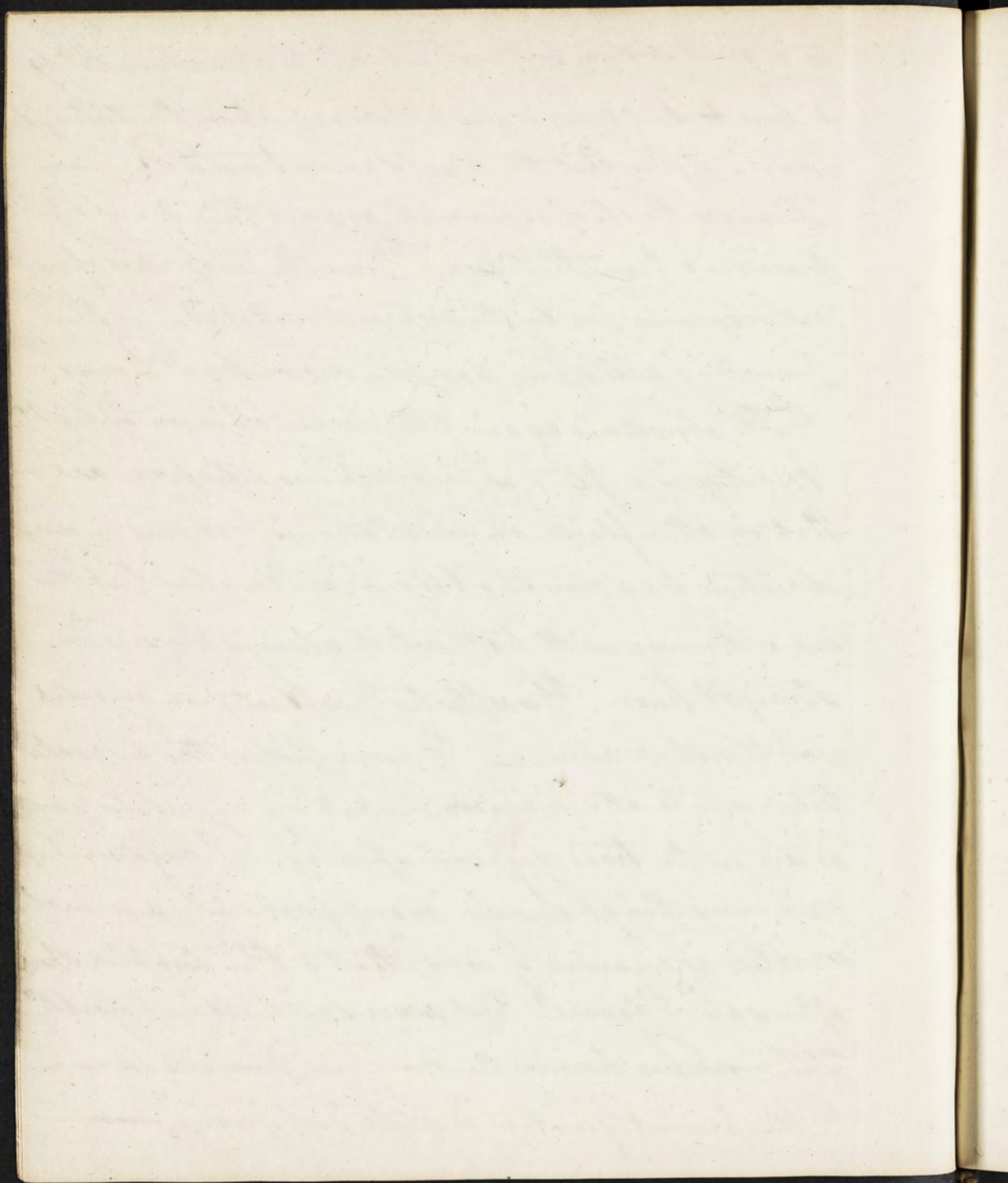
rated with light. If it be constantly emitted. it must
always be evident to us - whether the source of light be
present or not. If a candle be extinguished - not only the
light of the candle is extinguished - but all the light which
is in a sphere of 4 miles in diameter - for a candle in a dark
night can be seen at 2 miles distance. Then they say, it
has been demonstrated from the eclipses of Jupiter's satel-
lites - that light passes from the ~~sun~~ sun to the earth, in
93,000,000 of miles in 8' 13" & a little more - therefore the
whole sphere of which the Sun is the centre will be filled
in the same time - then a ray of light is only $\frac{1}{9}$ part of a
minute in passing 20,000 miles - but it has been shown
by I'chert that continuous vision exists for that time -
continuous vision may then be kept up altho' particles of
light are 20,000 miles distant from each other. They
then argue, if a ray of light passes 93. millions of miles
in 8' 13" - then the whole sphere having the sun as a cen-
tre will be illuminated & filled by particles in 8' 13".
but the emission is without end, & in this case light
would be concentrated in every part of the sphere



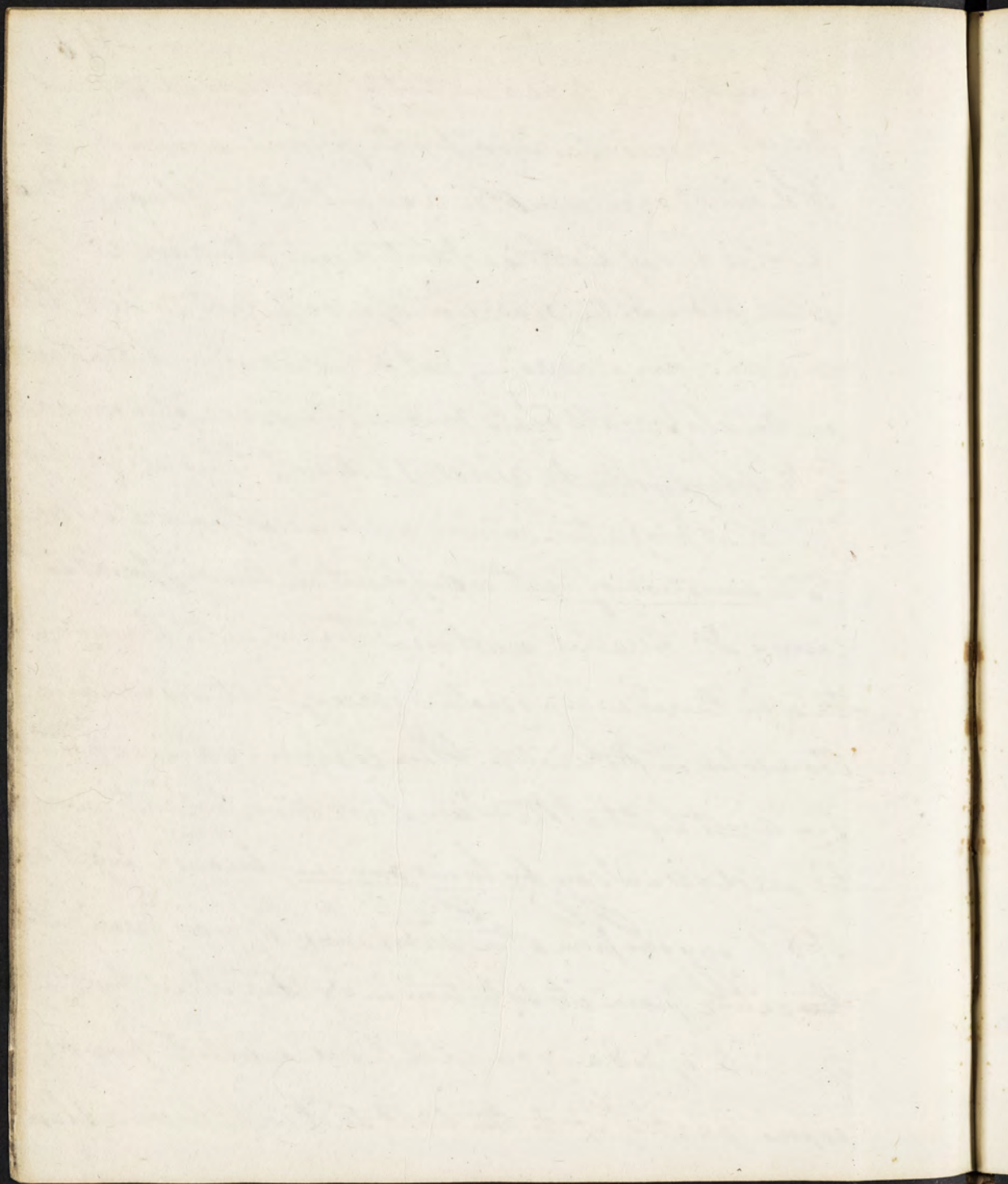
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to a great degree, but when light is accumulated by
a lens ~~the~~ 1000 times violent combustion then takes place.
How is it, then that the World is not melted? —

These are the chief arguments against the idea of light
proceeding from the Sun. How the properties of light
are accounted for by the supposition that it is a fluid
pervading all space, has been shown by Dr Young.

The objections against the second opinion of light
that it was a fluid as pervading all space, are —
that in other fluids an undulation is produced in every
direction by a resisting body — as ⁱⁿ air & water — but this
is not the case with light which always proceeds in
straight lines — It is reflected & refracted in angular
points not in curves — It never passes thro a crooked
tube — while other mediums which are undulating will
as air in the transmission of sound. Rousseau has
said many things wisely — many foolishly — a wise ob-
servation is recorded of him — "That a Philosopher should
often say "I ignore" — but never say "C'est impossible"
The more we know — the more we find is unknown
& the present question is still "sub judice," —

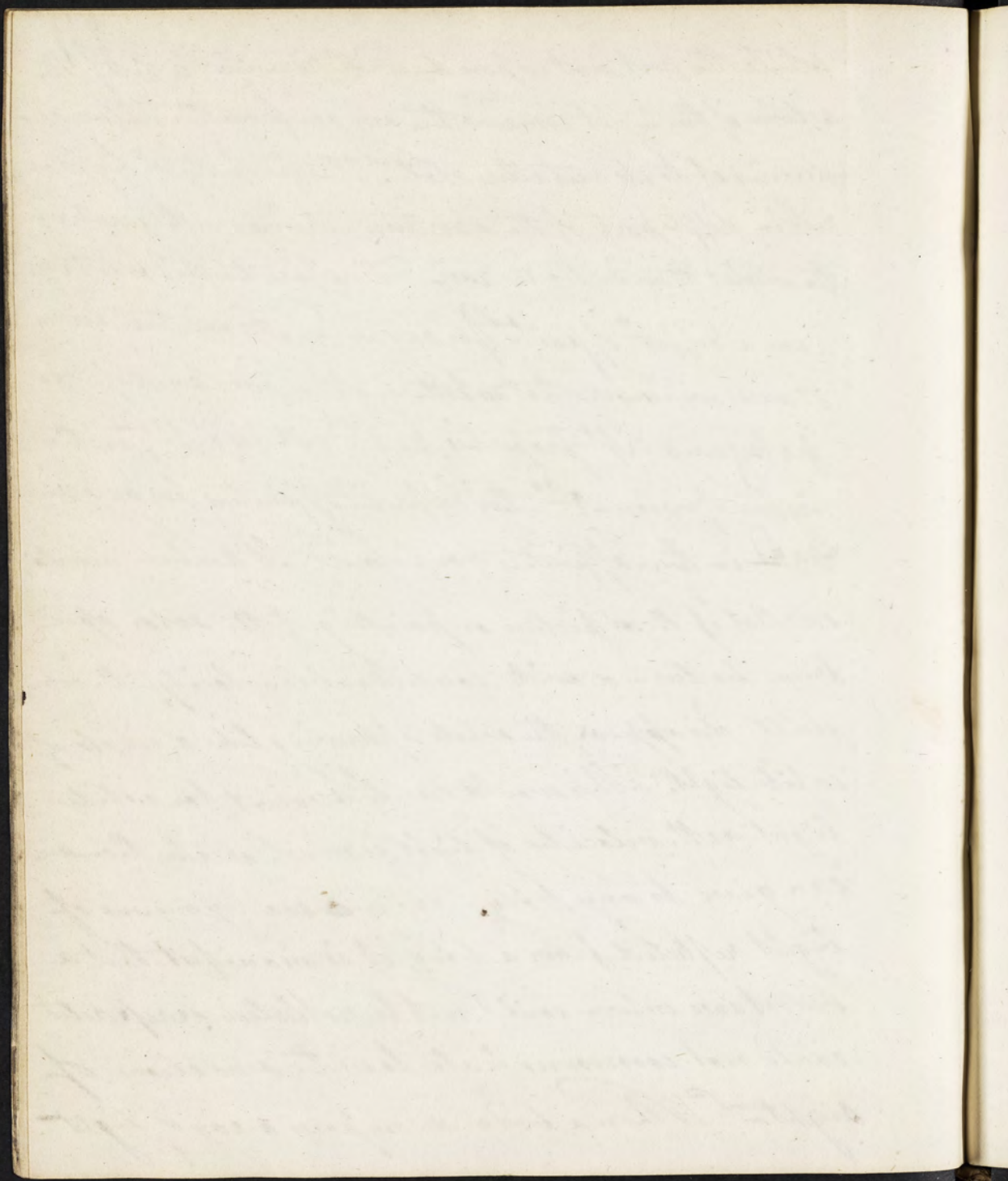


There appears to be a method of analysing light, not
 purely chemical. It is by the prism - which is a so-
 lid substance usually triangular & of glass. By it
 a solar ray of light is separated into other rays, each of
 which produces the sensation of a different colour; this
 is a uniform occurrence, not accidental or dependant
 on the glass: all glass produces the same phenomena.
 These rays form the Solar Spectrum. They all possess
 different properties - even in a chemical point of view.
 The sensation of heat is different in the different co-
 lours - Dr Herschel ascertained that when the thermome-
 ter is in the red ray - a greater degree of heat is indicated
 than when in the violet. When Chlorine gas is exposed to
 the direct light of the Sun it is converted into muri-
 tic acid gas - I say by losing oxygen, because light ab-
 stracts oxygen from other substances: if you precipitate
~~the silver~~ silver from its solution in nitric acid by the
 muriate of soda - you will have a white powder,
 expose part of it to the light & it will become black.



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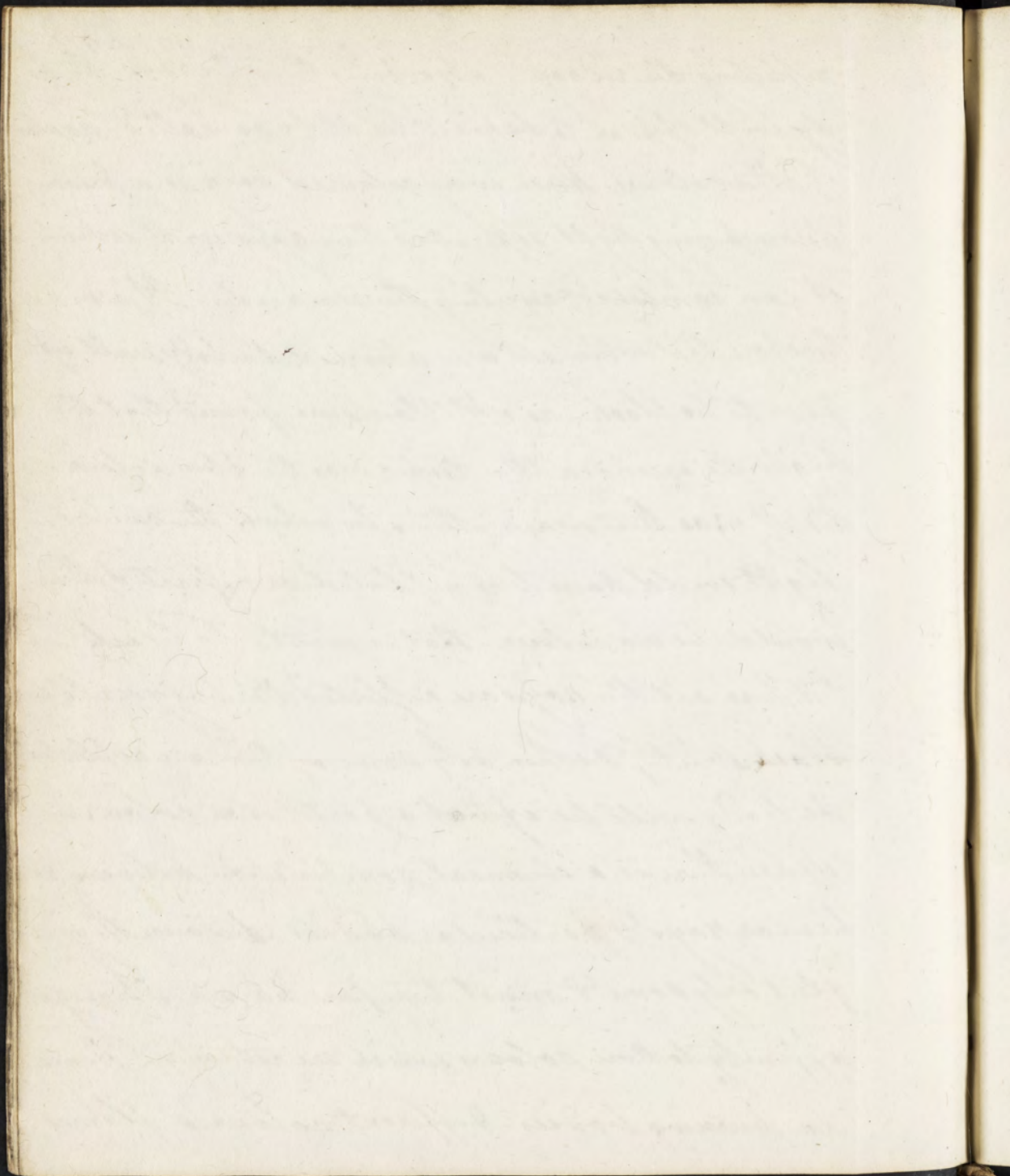
while the part not exposed will remain white; the action of the light ^{removes} the oxygen from the silver reducing it to its metallic state. This property of light varies in diff^t parts of the spectrum being much greater in the violet than in the red ray. Therefore the diff^t rays have a diff^t affinity for oxygen. From these circumstances we infer that white light is composed of rays possessing diff^t properties, as 1st acting diff^t on the organs of vision - 2nd they differ in affinities for oxygen - 3rd in their affinities for caloric. It has been ascertained that if the picture or painting of the solar spectrum be turned with considerable velocity - the colours will disappear the whole appearing like a circle of white light. This would easily account for white light as the velocity of light is much greater than we can give to any body. As we see by means of light reflected from a body it is manifest that a substance which could not be reflected or refracted could not communicate to us the sensation of sight. When a body decomposes a ray of light



reflecting the red ray & absorbing the other rays - the body will appear to be red - & will be so called - so also of other colours. Hence every coloured body is a prism, decomposing light - separating those rays with which it can combine & rejecting the remainder - It is evident therefore that when all are absorbed the body will appear to be black - as Mr. Vanpouren found that the higher he ascended - the deeper was the blue colour of the sky; as there was nothing by which the rays of light could have been reflected or refracted, there would be no colour - that is would be black -

Where all the rays are reflected the body will be ~~black~~ white, & when only some of them are reflected the body will be ~~of that~~ a particular colour -

Hence there is a chemical combination between particular rays & particular bodies - because they reflect only some & must therefore have a stronger affinity to those colours which are retained - Hence in burning bodies - different coloured flames



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are evident - so also when vegetables are growing
they absorb & combine with certain rays - ~~and~~ reflect-
ing the remainder which thus gives them a determi-
nate colour - That this is the case, is proved by the
fact, that when vegetables are tied up the part so
secluded from the light is of a white colour -

That a chemical union takes place in these cases is
evident from the fact - that the combination cannot be
destroyed, unless the body is decomposed - If the diff-
erent rays of the spectrum be collected in one spot, white
light will be again formed; the rainbow is formed
by the different refraction of the rays of light by the drop
of rain - Hence a ray of white light consists of
7 colorific rays - of colorific & of decomposing rays.
If the spectrum be divided into 360 equal parts - the
red ray will occupy 45 of these, orange 27, yel-
low 48, green 60, blue 60, indigo 40 - violet 80.
These are permanent properties of the diff-
erent rays - & therefore must depend on a permanent cause - &
must arise from a permanent difference in the rays.

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themselves. If one of these rays pass thro' a hole, it will retain the same properties - if two pass, they will be mixed & form a compound colour - The violet is the most refrangible - the red the least - & the others are intermediate in degree - The middle rays of the spectrum possess the greatest illuminating powers - The calorific rays were first pointed out by Herschel who found that the thermometer rose higher in an inch beyond the red ray than it did in any part of the spectrum. Hence they have been called the colourless, invisible heat-making rays.

The degrading rays were first noticed by Schiöden ^{Schroeder} who found that mur. of silver was blackened 20 sooner in the violet than in the red ray. — Light is refracted best by metallic surfaces - hence in glass mirrors the light passes thro' till it comes to the metallic plate - & on that account it is easy to determine the thickness of a mirror, by placing a finger on the glass, its thickness will be seen between the finger & the image, where it is then we infer that the quality is by no means good. Light

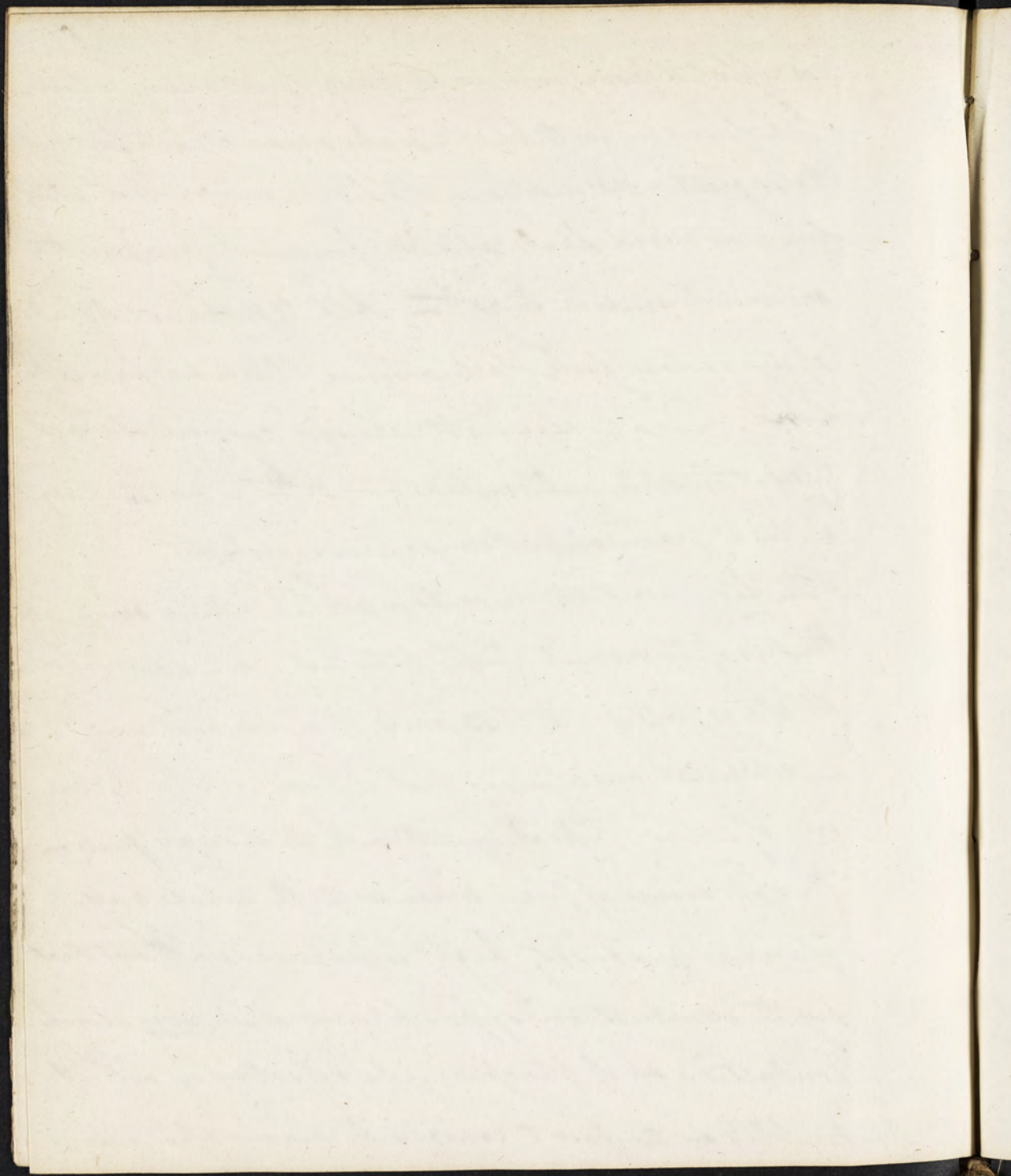
are there not red flames, & blue
flames etc.

is reflected from polished surfaces, of whatever colour. Glass coated with black sealing wax reflects but not to so great a degree, as when of a lighter colour - but it depicts very vivid Landscapes &c. for which purpose they are much used in Eng^d. All transparent liquids of every colour look black when a black surface is behind. In Solar light calorific rays are always present in chemical combination - That is not the case in light from combustion or culinary light.

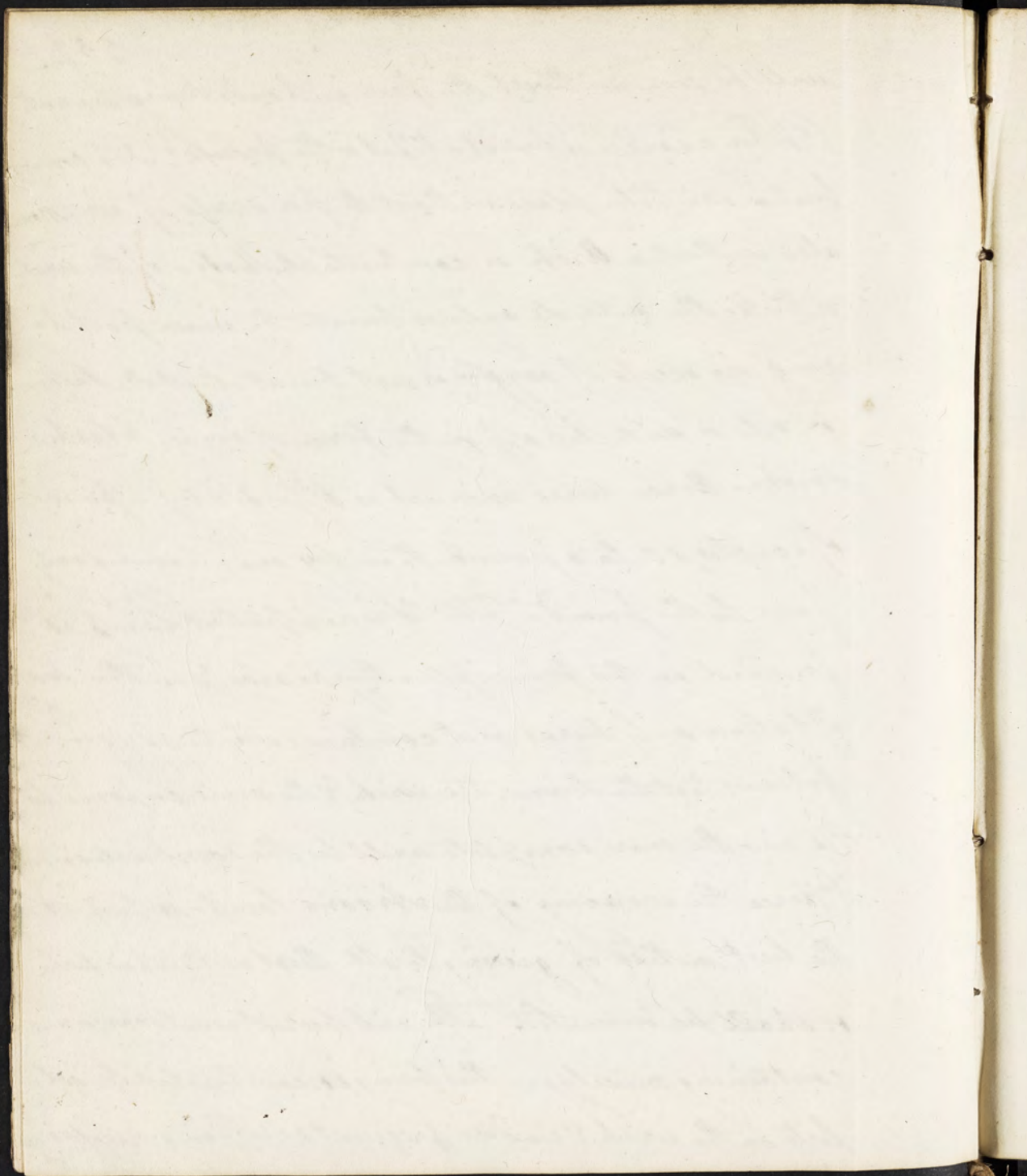
The light from the Moon contains ~~no~~ heat - this is owing to the size of the moon - & chiefly to the heat being absorbed. Water reflects & out of 10 parts of solar heat -

Artificial or culinary heat is produced by the burning of a body. Heat united with the red ray puts on the appearance of fire - when with the white ray -

flame is produced. Light is produced without heat by the combustion of phosphorus when very slowly conducted - so if phosphorus be dissolved in oil - & rubbed on the face & hands - a luminous appearance



will be seen - without the face or hands being burnt. (When a candle is burnt - What is the process? No combustion can take place without the free access of air - none also without a Wick or combustible body - if the wick is thick - the outside only is burnt - the inner part having no access of oxygen is not burnt - but the tallow or oil is distilled off in the form of dense, black smoke - Hence twice as much is afforded by a pound of candles, 10 to a pound - than by one - having only four to the pound - The French patent lamp is founded on this principle - they reasoned in this way if tallow only burns as it combines with oxygen, it follows that the thinner the wick & the more exposed to the air - the more complete will be the combustion - Hence the economy of the Argand's lamp - which is the best method of giving light that either has been or shall be invented. The oil burnt is seldom pure containing muckage - this being incombustible collects on the wick & renders frequent snuffing necessary.

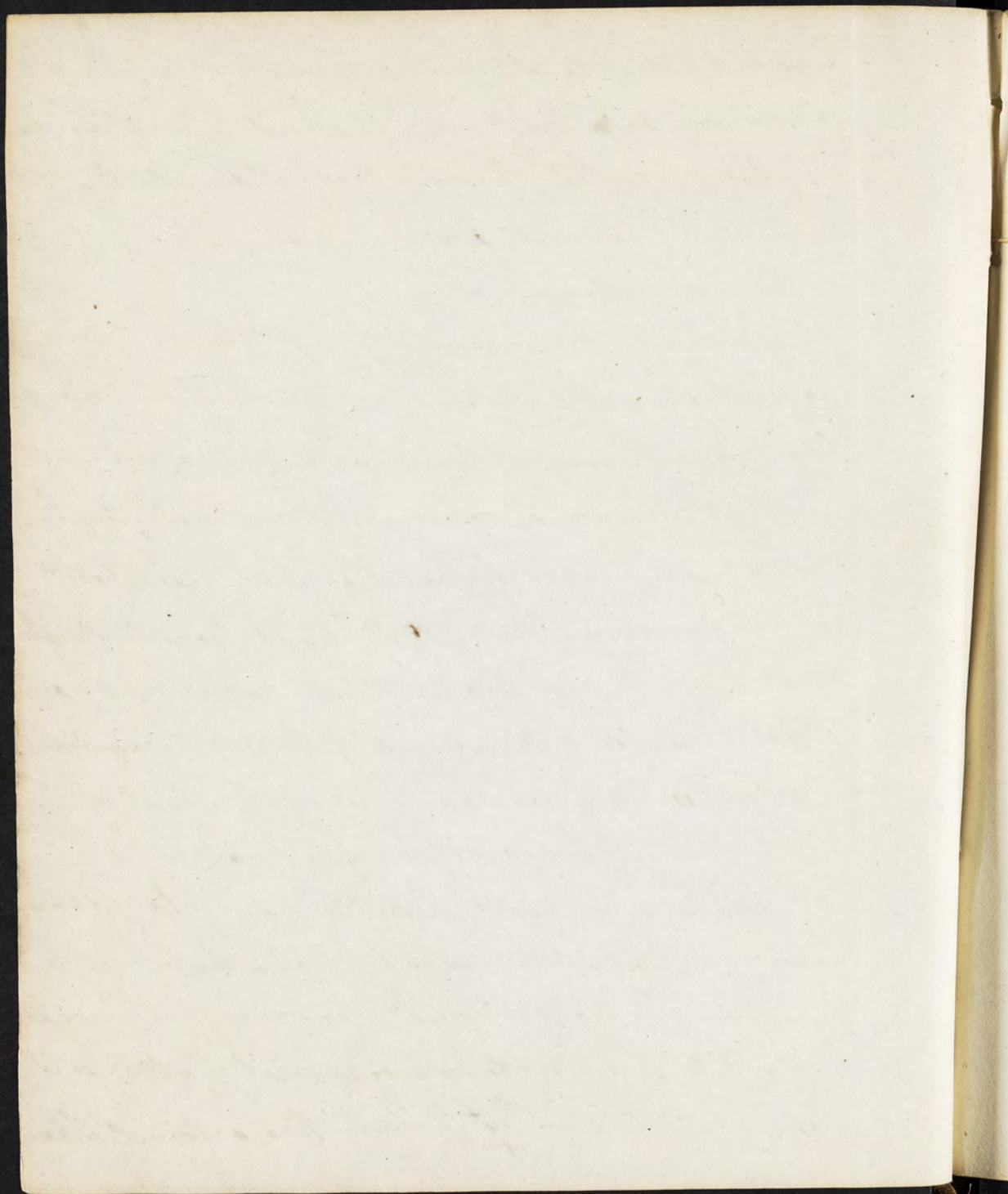


The best method to clear oil is to wash it in diluted Sulphuric acid - with which it should be well agitated - this coagulates the mucilage. it should then be well agitated with powdered oak bark - suffered to subside & strained -

To measure the intensity of light the best way by concentrating it by means of reflection - For instance let an Argand's Lamp be placed on one end of a mantle piece & a number of candles on the other end; midway & somewhat anteriorly hold a clean glass bottle, or some similar reflector - the light from the lamp & that from the candles will then be concentrated on opposite walls - & the intensity of the two be compared.

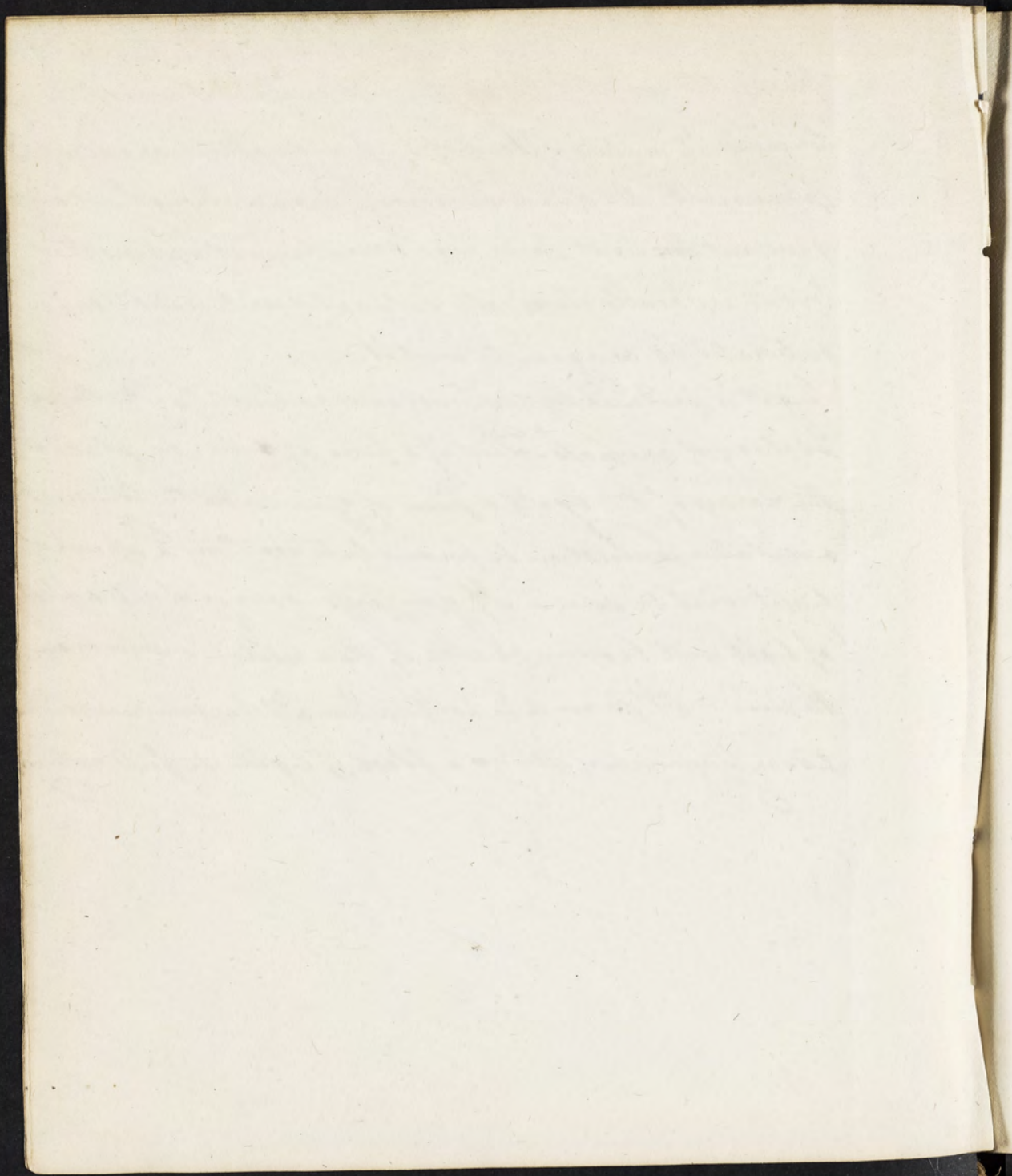
Light arises from some cases of chemical mixture - how this is we do not exactly know -

Phosphorescent light is emitted by vegetables in a semi putrescent state. - also by fish when about to putrefy - The light frequent by covering the ocean, is thought to be owing to some animal matter or to some shell fish - By filtering thro' a towel I have



frequently collected this matter but could not exactly determine its nature. Some of the precious stones are also phosphorescent. The diamond removed from a strong light will give out ~~the~~ light for a long time - hence it appears that bodies are really chemically saturated with light & super-saturated so as again to emit it.

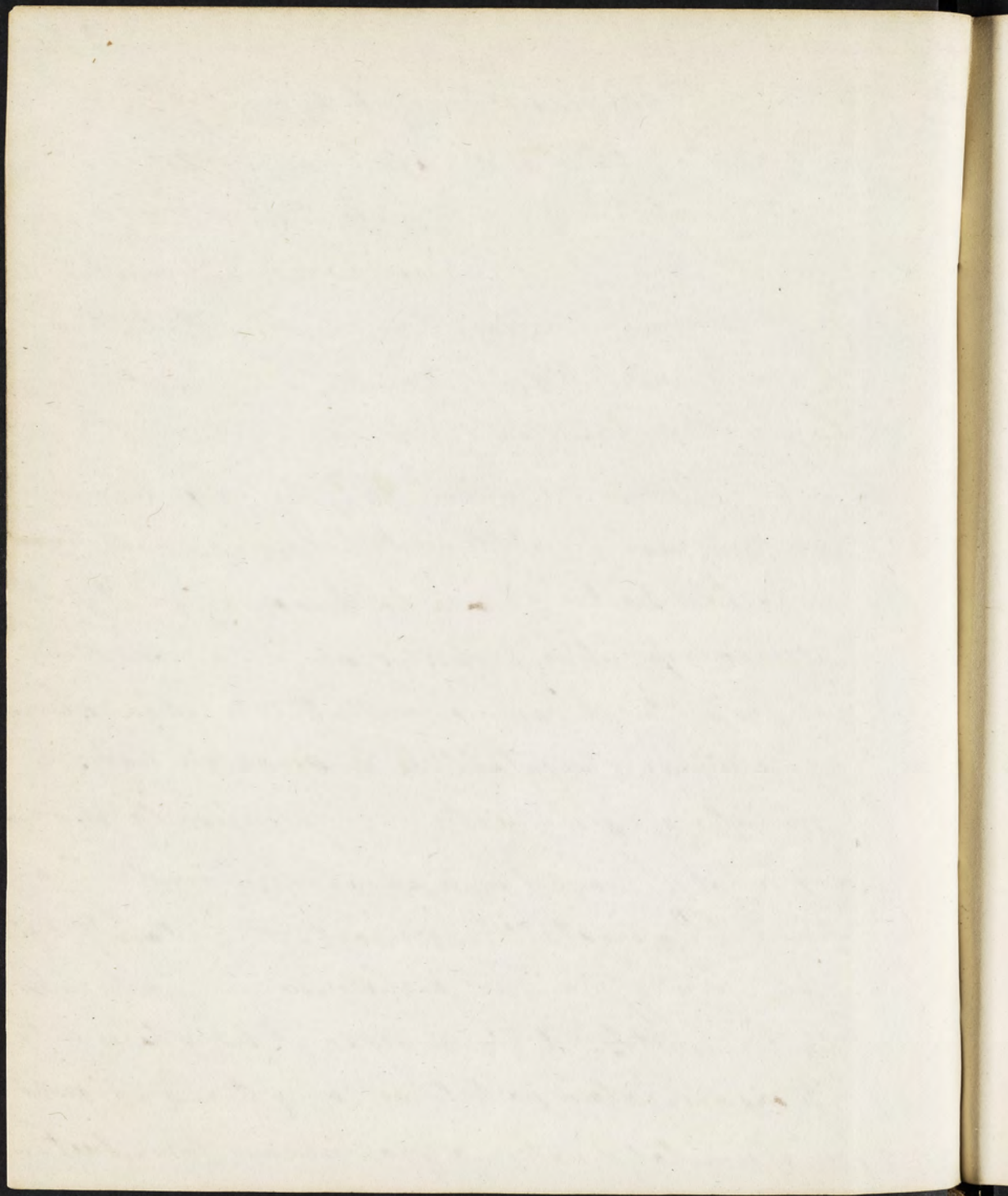
Light is produced by circumstances connected with the physiology of animals. Thus if a piece of silver be placed at the corner of the eye & a piece of zinc under the tongue, & a metallic connection be formed between them, a spark of light will be seen - If you press your eyeball a flash of light will be seen - so also if you receive a blow on the head - A man who has been hanged has been re-animated - only remembers seeing a flash of light - he feels nothing



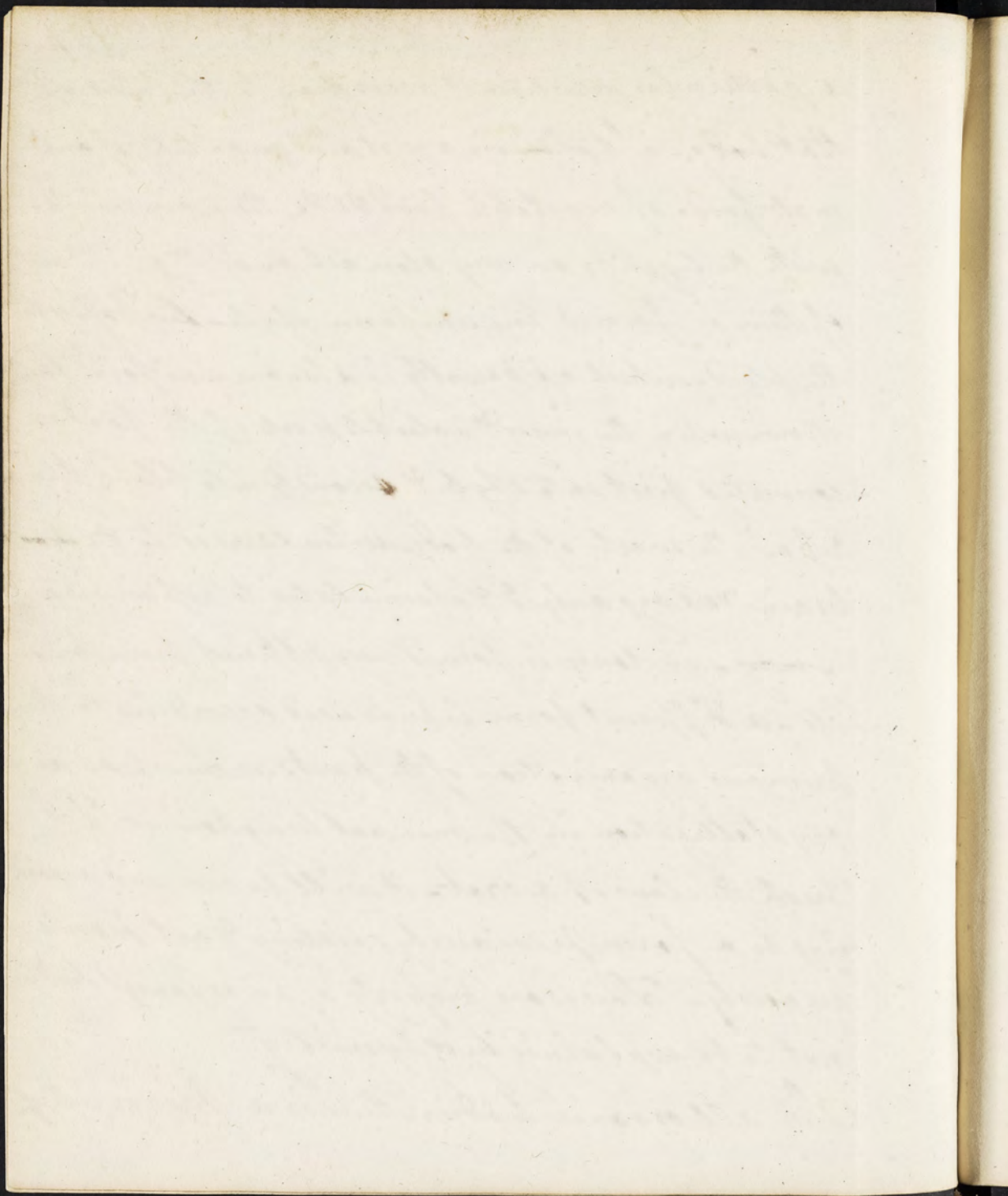
Pharmaceutical Chemistry.

It is impossible to deliver a full course of lectures on chemistry in less than 9 months - As I am limited to about 3 months I must therefore devote your time, to what is likely to be most beneficial to my auditors. With this view I proceed now to notice that part of our subject which relates to the preparation of medicines.

Of Materia Medica & Physiology - Chemistry bears no inconsiderable part, but by no means the most important part - When a body is organized it possesses some peculiar properties as well as some chemical properties in common with other substances. Every animal & vegetable is an organized body; the particles are assimilated under peculiar laws, forming what I would term an organized crystallization - By crystallization I mean the certain & definite form assumed by particles when uninterrupted by circumstances. When an organized body takes in by its organs, certain particles as food, these are digested & assimilated not in a promiscuous form, but in



a particular direction & according to the laws of that body. - It takes in a certain quantity of animal food. of vegetable food &c &c these are mixed with the liquids in my stomach duod ^m &c & out of them is formed one uniform chyle - this passes to the blood - which apparently is also one uniform fluid. Now - when the juices & soluble parts of the food are converted first into chyle & secondly into blood, they repair the waste of the body - when carried to the head brain - &c are organized & assimilated to repair its wear. a ~~new~~ substance is formed very different from muscle - a different form is produced according to the previous organization of the part: as much as as crystallization in the mineral kingdom - If I break the claw of a crab - it will be renewed according to a form previously existing & not promiscuously - This is one property of an organized body not to be explained by chemistry - In all organic bodies - there is a principle of

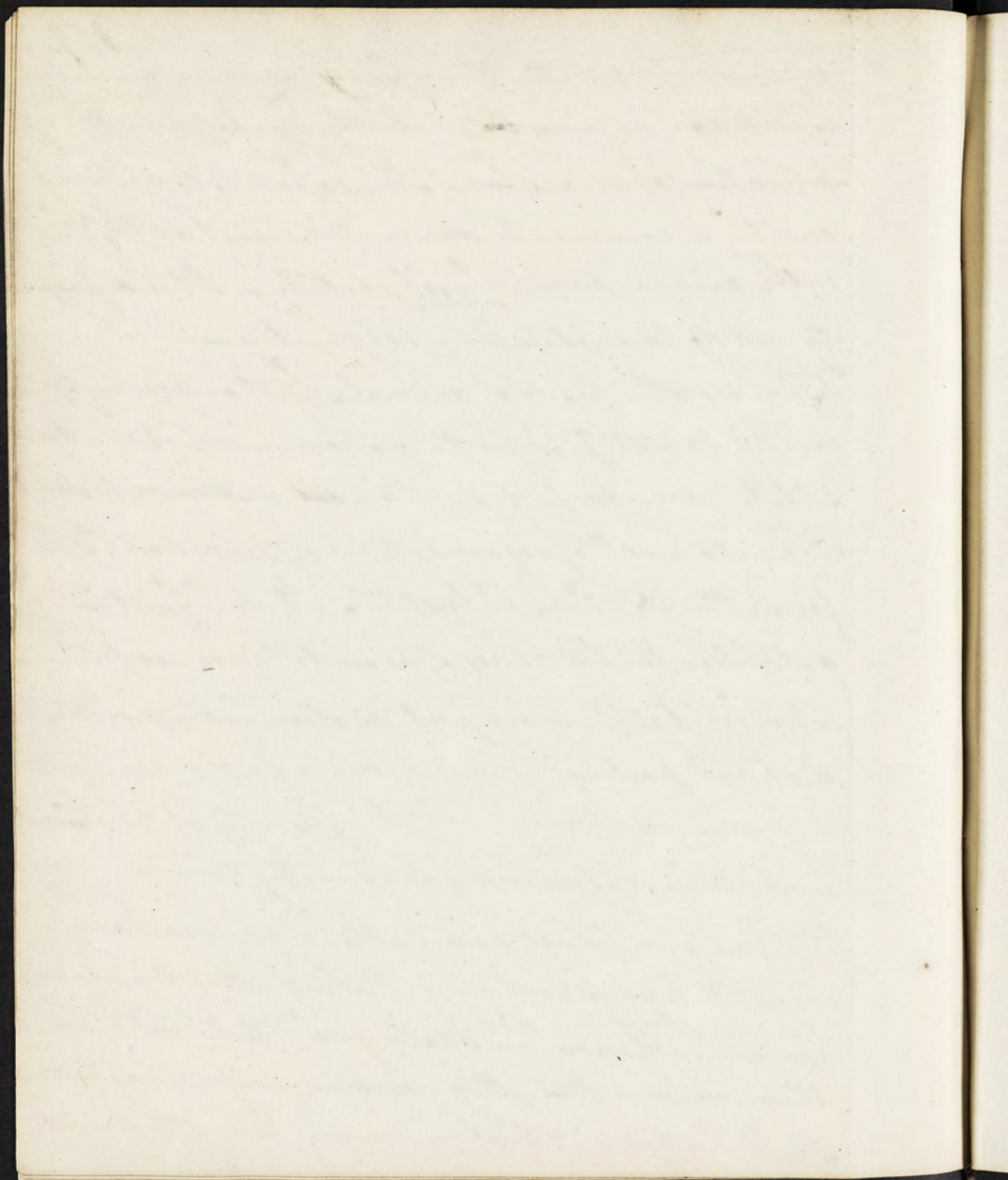


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life-coexisting with them - They have certain fibres which can be more ~~or~~ violently agitated by the application of stimulus - This capability of being excited is common to animals & vegetables, & is well enough termed Irritability - It is a property not to be explained by Chemistry -

There are other parts of animal sub. & ancles, which when excited do not produce the motions in which irritability consists, but a certain ~~set~~ motion is produced in a certain set of organs - exciting Sensation - This forms the Verbal System. It does ^{not} exist in Vegetables. The Peristaltic appears to be an exception, & when irritated in one part, motion is produced in a distant part - This is a single fact - & can lead to no general conclusion. This property of an animal is not to be explained by Chemistry -

When you place on a table a glass containing acid - & a glass containing Potash - there they would remain in prison - "in statu quo" to the end of times. When we mix them, they combine under circumstances which we know & therefore we can predict the results.



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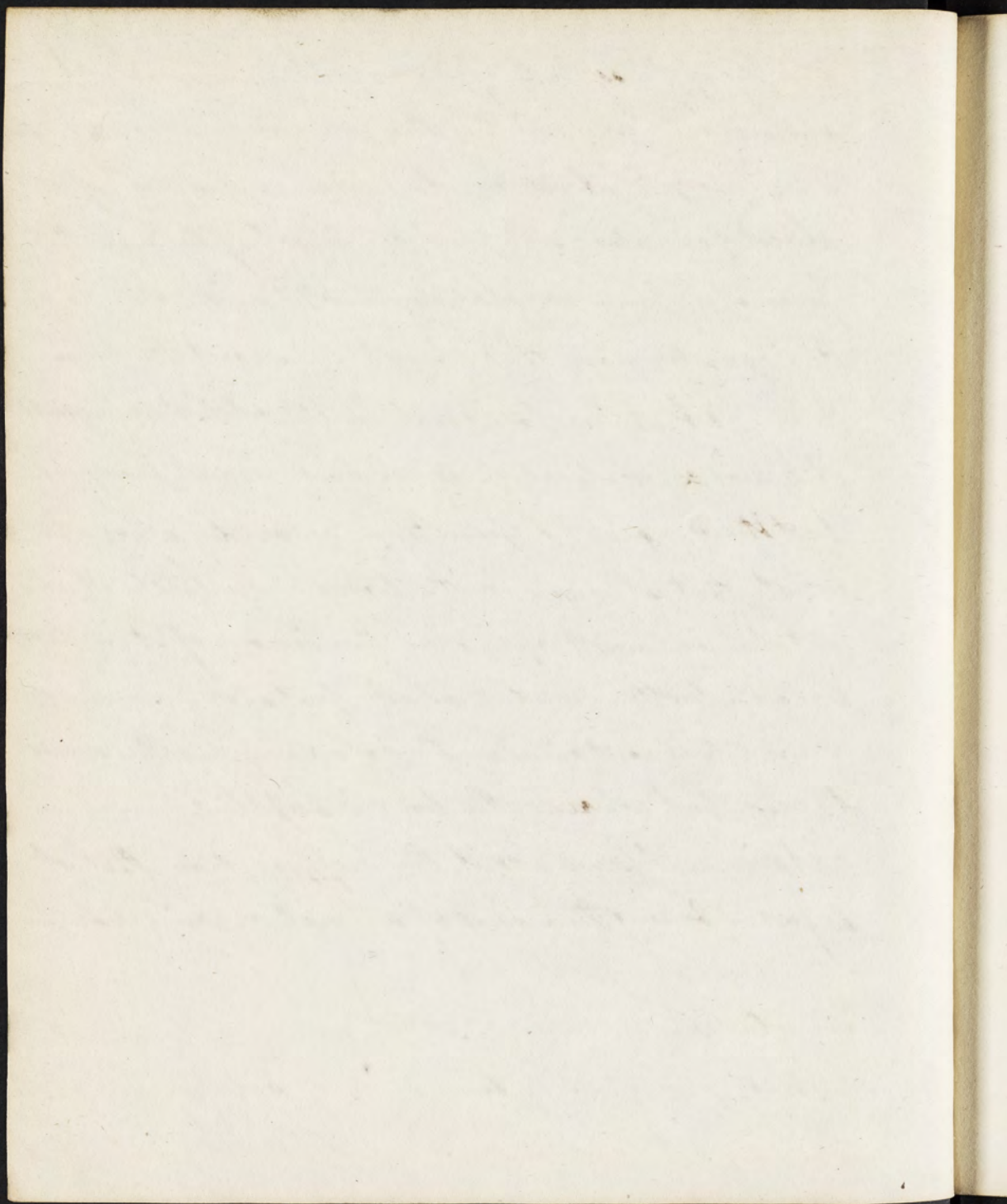
but in an organized body where everything is in a continual flux - where there is no particle which you can fix - I say - in such cases where the ground is moving under you - you can never predict with the same precision what will be the result - All the circumstances modify the action of substances in such a way there is no arguing on the point - When however a substance is taken into the body it must have some effect - this it is our business to investigate ~~and~~ in what way modified - As chemical affinity is modified by the laws of organization, it is reasonable to infer - that the laws of organization are in some measure modified by the laws of Affinity; acting on the particles composing the body - I will therefore briefly run over in the first place the chemical properties of the parts of the body so far as they are yet known -

Man is a vertebrate animal - he rests on bones - which therefore naturally first claim our attention - It is now well ascertained that bone consists

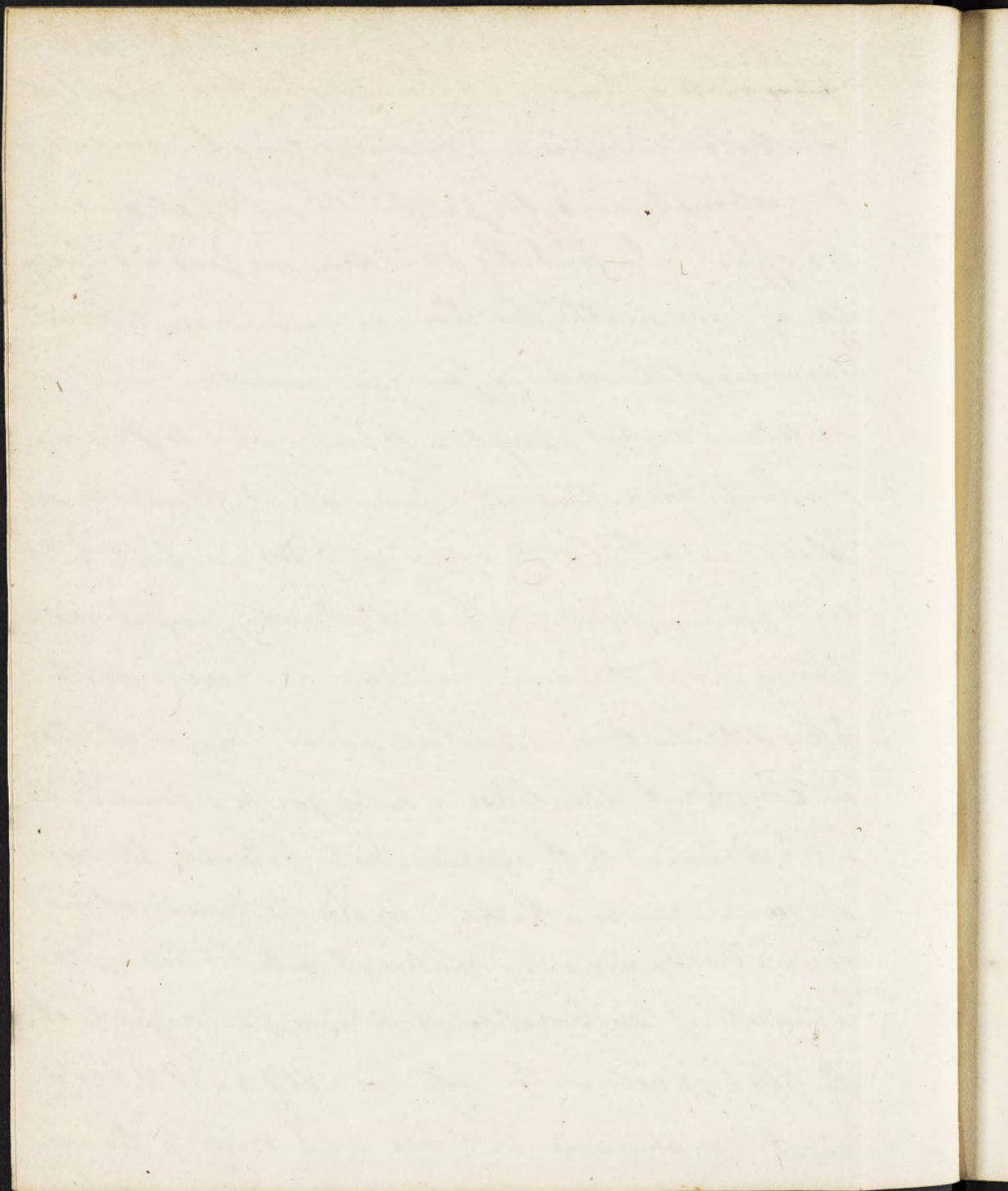
X Phosphoric acid exists in the cereals

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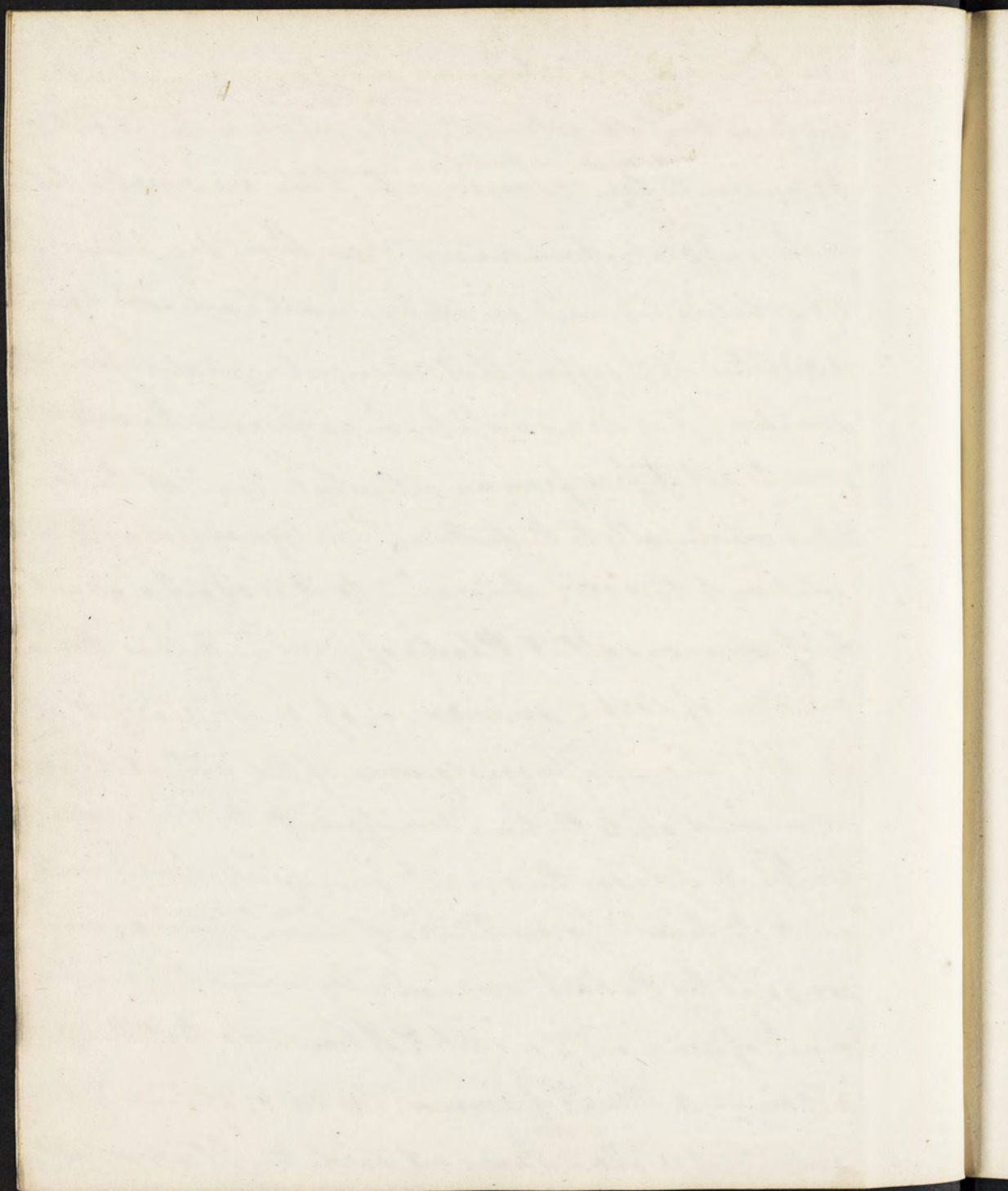
chiefly of Phosphate of Lime. The lime is taken in
almost all our food - It is therefore easily accounted for
The Prop^o Acid exists in mineral subs^o of the
oldest formation; we find the phos^o of lime in the
form of a Green crystal, embedded in the ~~cr~~ ^{rock} in
this country - on the Schuylkill about German^m
H. H. - As it therefore exists in the oldest minerals
it is not ~~x~~ peculiarly produced by animal processes -
but there is great difficulty in accounting for the
whole, that is found in the body - very little, if any
is taken in - with our food - there is none of it in tea,
bread - butter - meat & salad, potatoes - a minute
quantity is contained in the colouring matter of vege-
tables - but whence the body is supplied - is very un-
certain, unless we adopt the supposition - that it
is formed during the process of animal organization -
It is not only found in the bones - but in large is several
excretions, particularly in the urine - Bones contain
37th of phosphate of lime - 1st of prop^o of magnesi-
a - 10 parts of carb^o of lime - a small quantity of



~~sulphate~~
~~phosphate~~ of lime - various proportions of gelatine
 The Gelatine is procured by subjecting the bone to fire
 the carbonates are dissipated - & the oil & fat are distil-
 led off. In Ricketty children we find a deficiency
 of bony matter, the bones remaining in the carti-
 laginous state - as in infancy - To ascertain what is
 cartilage & what phosphate of lime - add to the bone
 muriatic acid - this will dissolve all the phosphates - sul-
 phates & carbon^e - but the cartilage being insoluble in it
 will remain. Marrow is nearly the same as fat - con-
 taining a little more mucilage - I have in another
 place detailed the use to which a dead horse is applied
 in Eng^d - A dead horse is sold for $\frac{1}{2}$ a guinea - The
 skin is carried to the curriers - who scrape it - press out
 the juices - remove the hair by lime & by several pro-
 cesses already detailed makes it into leather - The
 students of Comparative Anatomy then dissect it,
 the flesh is sold in the city for cat's meat & dog's
 meat - Sometimes the bones are carried to the ma-



-manufacturers of Cart-Grease about London - where they
 are first boiled to extract the fat - which is then boiled
 down with tar. Sometimes the bones are carried to the
 makers of Sal: Ammoniac - from them are procured
 the volatile liquor & an empyreumatic oil. The liquor
 is distilled off & suffered to stand in cylindrical vessel - after
 sometime it is drawn off by an opening in the middle
 so as to get it free from an oil which floats at the top -
 & one which falls to the bottom. This liquor is chiefly a
 solution of the Carb: Ammon^a - to it is added a quanti-
 ty of common salt - & Plaster of Paris - There is then a
 mixture of carb: ammon: - of mur: Sod: & of
 Sulph: Lime - The consequence of this is - that the sulph-
 uric Acid quits the lime & unites with the Soda forming
 Sulphate of Soda - the muri^c acid - quits Soda - unites
 with the lime & forms - Mur: of Lime. This is again de-
 composed by the carb: ammon^a - by which is formed a
 mur: of ammon^a & a carb: of lime - So that there are
 obtained - a Mur: of ammon: - a carb: of lime - & a
 sulph^c of Soda - Being set aside the Glauber salt -



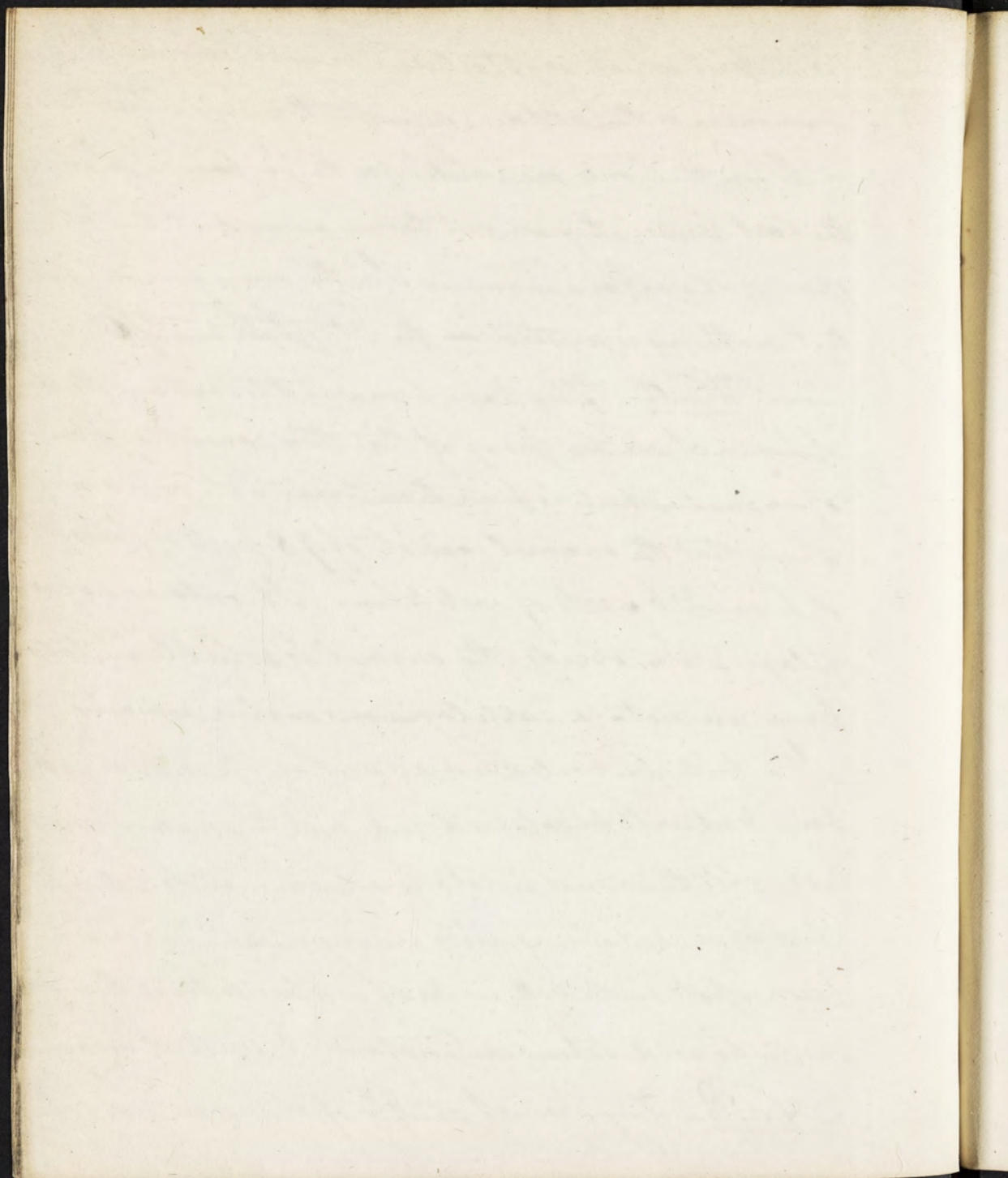
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is the first which crystallizes & may be removed - the sal-
ammoniac is then obtained by further crystallization.

- When the bones are boiled for the purpose of making
the best Grease - they are not thrown away but they are
ground & used as a manure - In this way you may see
that nothing is wasted in the Old Countries of Europe

— Teeth - They have been said to contain fluates
of lime. I see no proof of this - they consist of bone
& enamel - which is finer than bone. Late experiments
show that the enamel consists of $\frac{1}{8}$ parts of phosph^r
of lime & $\frac{1}{6}$ parts of carbⁿ & lime - It contains no car-
tilage - In acids - the enamel is soluble "in toto".
Bones are not - a cartilaginous matter remains -

If a tooth be boiled in a solution of madder - the
bony part will be coloured red - but the enamel will
not - All the enamel is totally soluble in acids & therefore
dentifrices containing acids are injurious - To remove
black spots on the teeth we may venture to touch them with
Muriatic acid - taken care instantly to wash it away

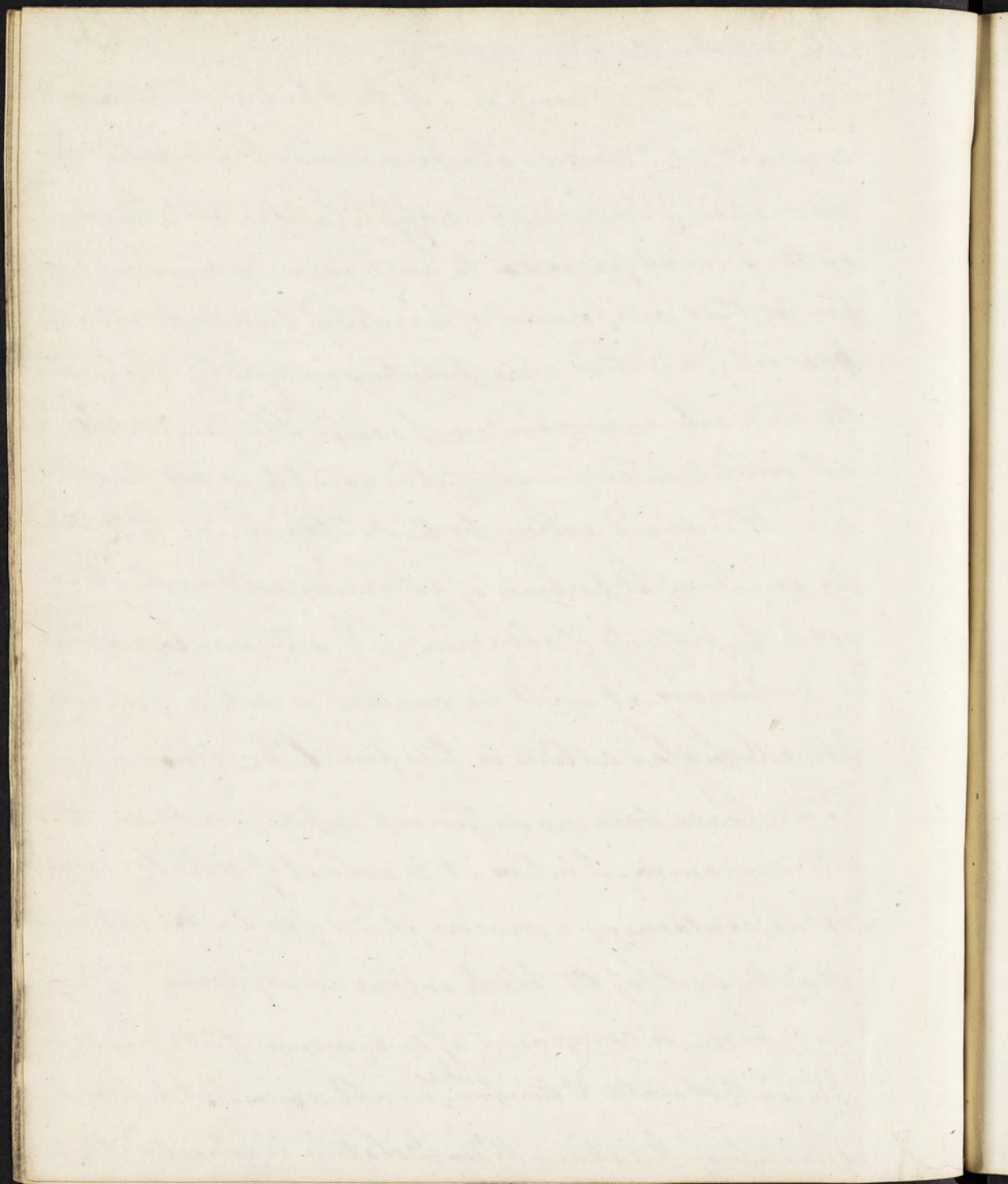
Nails - They consist chiefly of albumen not solu-



-ble in hot water -

Skin. This is composed of the Epidermis - rete mu-
cosum - & cutis vera. The former may be separated by
maceration & by various applications. Mr. Helden
on this account proposed to cure Corns by means of blis-
ters - as these are formed of hardened cuticle, having their
base exterior - & their apex pointing inwardly. I apprehend
this will only answer in recent cases. The epidermis is
not soluble in cold water - it is soluble in all the alkali-
es. It is tinged yellow by the & true acid. If touched
by ammonia it becomes of an orange colour - this is ex-
act by the property of albumen. If albumen be suspended
in a chimney - it will be converted into a yellow
barned mass - cuticle is therefore like albumen -

There have been no sufficient experiments on the
rete-mucosum. I believe it to consist of cellular mem-
brane; containing a mucus fluid for lubrication
it is the seat of the black colour in Africans. The
cutis vera is composed of interwoven fibres - solu-
ble in hot water & therefore ^{has} no albumen but a large
quantity of Gelatine - When Gelatine is extracted - there

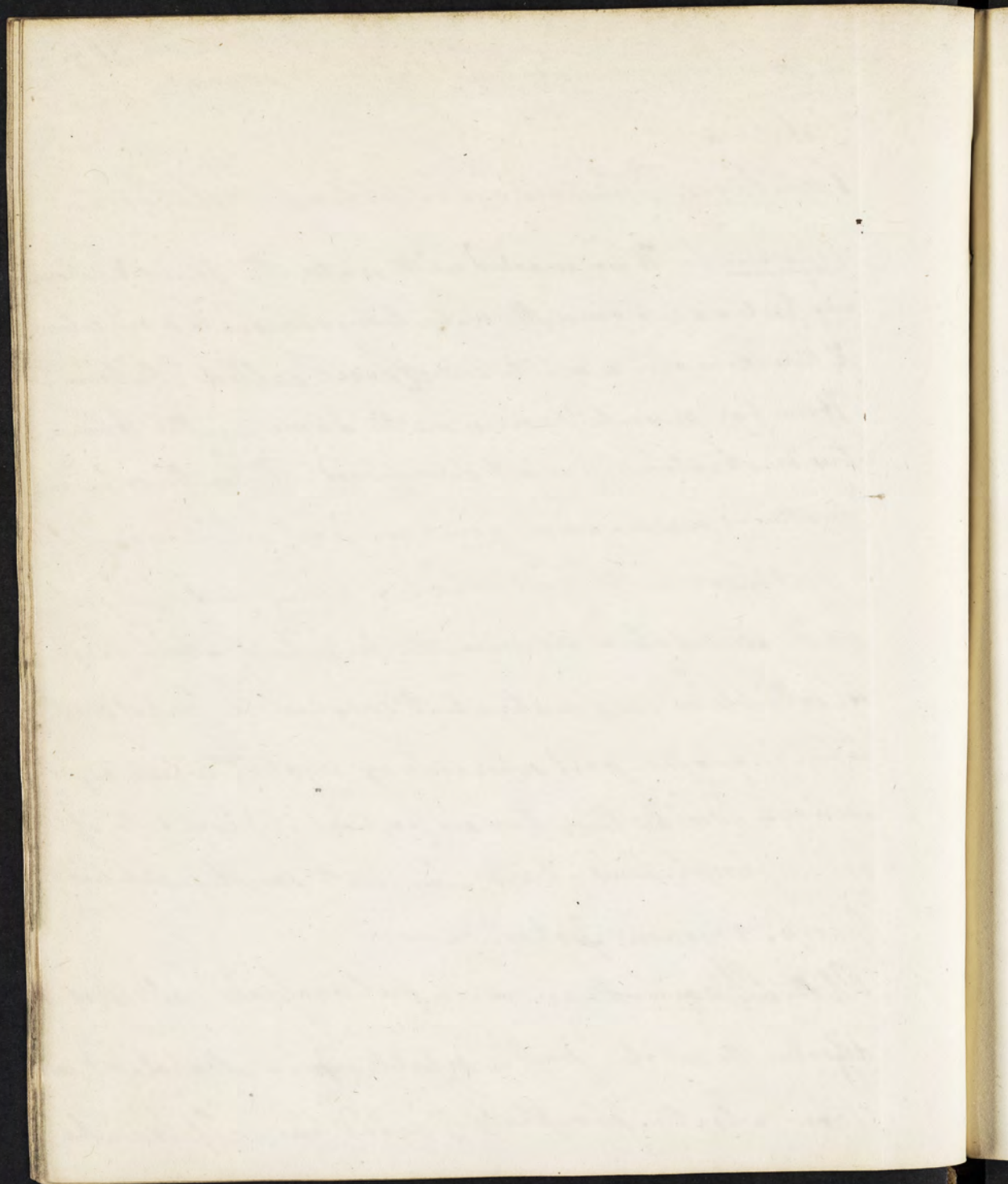


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is some fibrin remaining - but this is convertible into
Gelatine.

Cartilages. These are convertible into Gelatine ^{no.}

Muscles - When washed with water the fluid & colour-
ing parts are removed - the water being changed to a red colour.
& there remains a white substance - called Fibrin -
How far muscle & nerve are the same - neither Chemis-
try or Anatomy has yet determined - When the colouring
matter is washed away - you have part which coagulates
- part by serum - & part which is more solid - The part
which coagulates is albumen - the properties of which that it
is soluble in cold water - but coagulable by hot water.
There is another part separable by alcohol - which is pe-
culiar - Besides these there are portions of phosphate of
soda - phosph: lime - carb: lime - with small quantities of
phosph: ammon: potash &c -

Of the Brain - there is no useful analysis - alkalies
dissolve the whole - part is soluble ~~in~~ in alcohol - it con-
tains also the phosphates of soda & lime - If brain be



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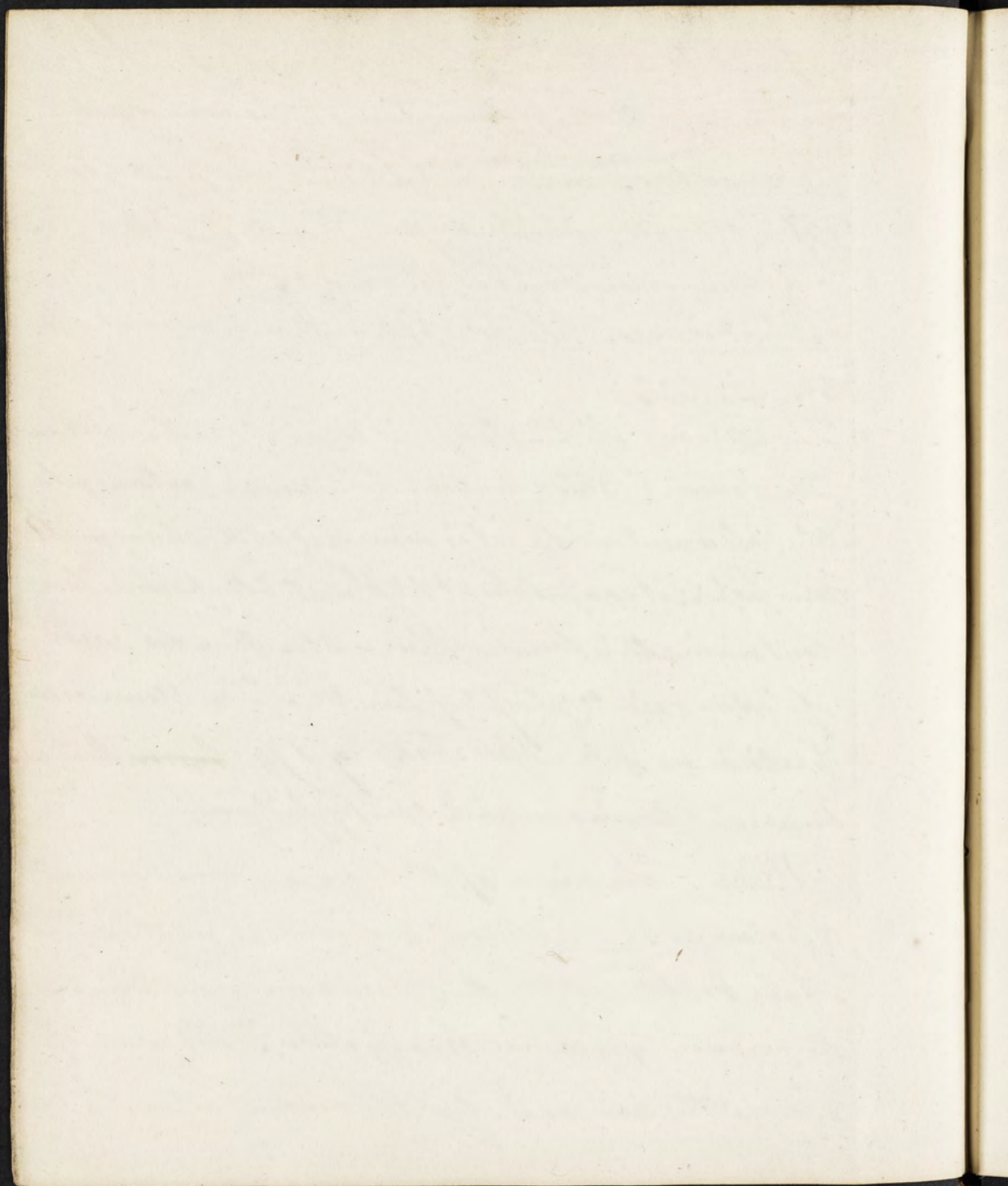
exposed to a strong solution of corros: subl: it will
be hardened the soft parts being coagulated.

Hair. This is peculiar in containing sulphur - by it-
self - & as sulphurated hydrogen. Besides this there are
oil: manganese: phosph: lime &c &c -

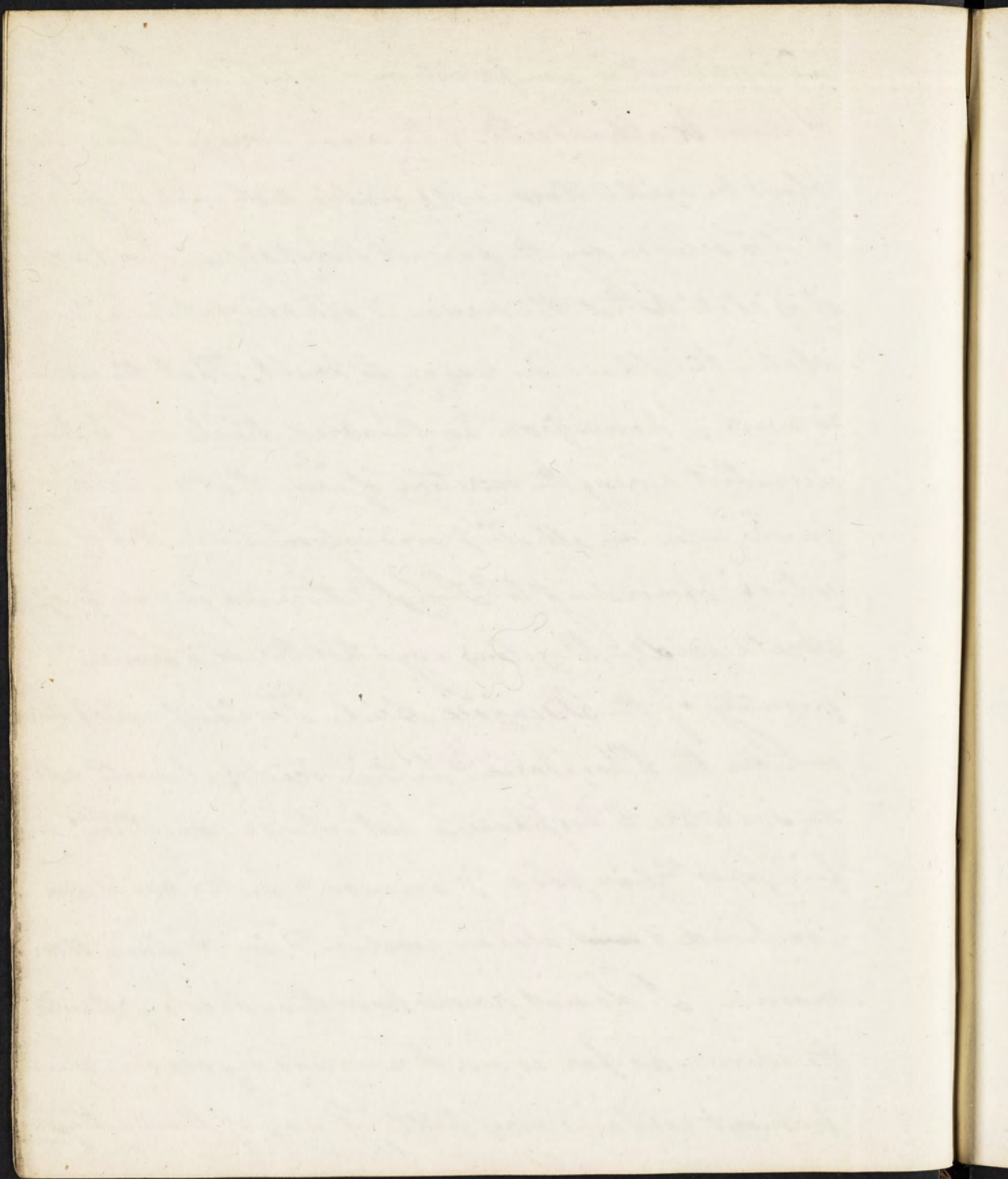
Blood vessels - Glands - Of these there is no satisfac-
tory analysis -

The Blood: If this stands - it separates into 2 substances
The Serum & Crassamentum - The serum contains gela-
-tine, albumen - soda - it is somewhat acid changing it -
mus paper: it coagulates at 156° - it blackens silver,
containing therefore sulphur - also there are carb^e
of Soda - carb^e & phosph^e of lime &c. The Crassament
particles are of the Spec: Grav^y of 1/4. ~~There~~ these can
be washed leaving behind chiefly fibrin -

Urine. The serum of the blood appears on exposure
to possess rather alkaliescent properties. I mentioned, that
I have doubts - whether the phosphoric acid was not
the produce of animal organization. The urine of
all healthy persons is slightly acid - & when there is



indigestion it is uniformly more acid. Now if the Serum be alkaliescent. & the urine secreted from the blood be acid - How is it? unless a change is effected as it is acted on by the animal substances. In books it is stated that the serum is alkaliescent in a healthy state - this I have no reason to doubt. That the urine is acid I know from one hundred trials. It is then clear that during the secretion of urine that an acid is formed where an alkali previously existed. What acid is this? According to Thomson there is a quantity of Acetic acid, - Bozelius says that there is a small quantity of the Benzoic Acid. The chief acids however are the Phosphoric & Lactic Acids: almost all the salts are Phosphates - but whence come these? we find phos^{ph} lime, soda - & ammon^{ia} lactic acid uncombined & ~~and~~ also in combin^{ed} with lime, Ammonia. I do not know how these acids get into the urine - as far as our knowledge goes our nutriment contains very little, if any of them. The pro

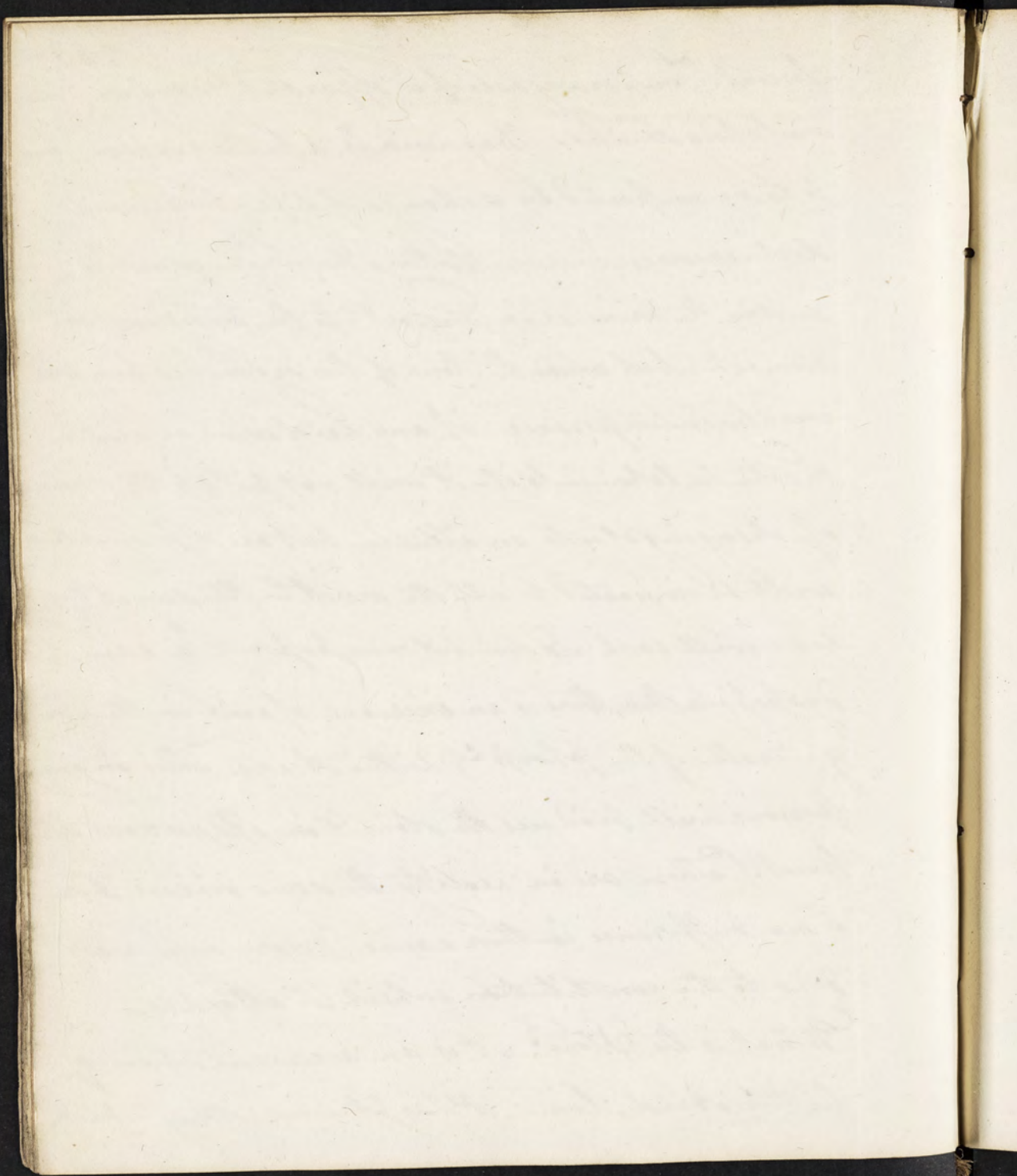


probability is that they are the product of animaliza-
 tion. Ammonia will precipitate phosph^r & of lime
 & magnesia - also albumen & Gelatine. If inspissat-
 cooled & crystallized. & if the crystals be dissolved
 in Alcohol you will have a saline substance.
Urea which will comprise $\frac{1}{10}$ of the whole. That
 urine contains Phosph^r Acid is well known - as from
 it Phosphorus was formerly obtained. This was done
 by adding acetate of lead to urine - this united with
 the Phosph^r & Uric Acids. This last was then driven
 off by heat - the phosph^r of lead remaining by distil-
 lation with charcoal - the lead was revived.
 There is in urine, also acetic-muri^c & Benzoic Acid.
 phosph^r ~~lime~~ & Urates of lime, ammonia & soda -
 The soda is obtain^d from the salt which we eat &
 the ammonia - from our animal food.
 When digestion is impaired there is a preterna-
 tural quantity of acid in the stomach - in such cases
 it is not probable that the serum of the blood is alka-

The first of these is the
 fact that the number of
 cases of the disease has
 increased in the last few
 years. This is due to the
 fact that the disease is
 more common in the
 tropics than in the
 temperate zones. It is
 also more common in the
 lower classes of society
 than in the upper classes.
 The second fact is that
 the disease is more
 common in the summer
 months than in the winter
 months. This is due to the
 fact that the disease is
 more common in the
 tropics than in the
 temperate zones. It is
 also more common in the
 lower classes of society
 than in the upper classes.
 The third fact is that
 the disease is more
 common in the lower
 classes of society than
 in the upper classes.
 This is due to the fact
 that the disease is more
 common in the tropics
 than in the temperate
 zones. It is also more
 common in the lower
 classes of society than
 in the upper classes.
 The fourth fact is that
 the disease is more
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 in the upper classes.
 This is due to the fact
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 The fifth fact is that
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 This is due to the fact
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 The sixth fact is that
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 This is due to the fact
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 This is due to the fact
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 The eighth fact is that
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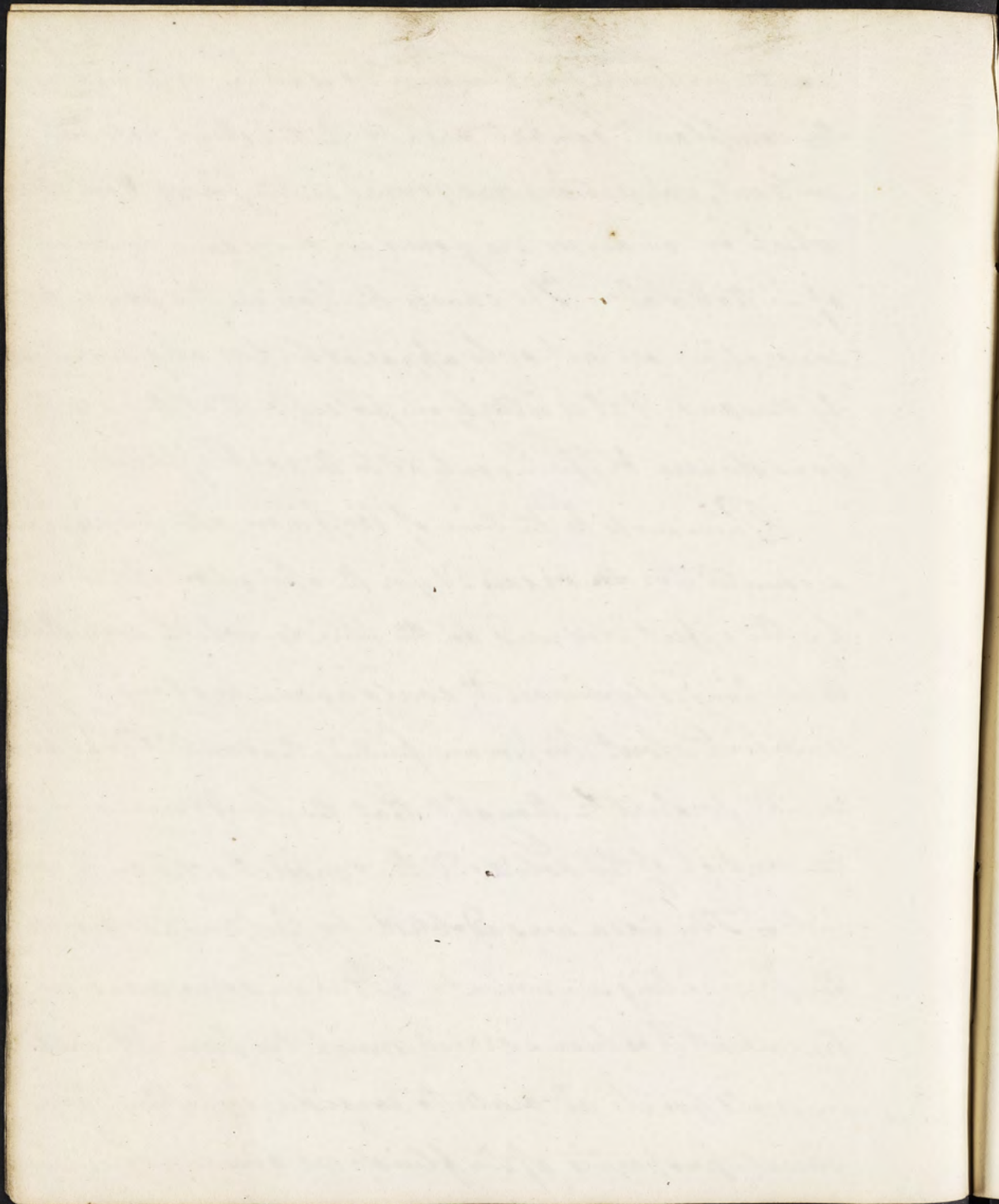
-lescent. Temporary relief is afforded by warm stimulating drinks. Magnesia is a better remedy. Stone is to be imparted by a change of life - by animal diet - exercise, warm clothing &c. - The quantity of acid in the urine is in proportion to the acid juices in the stomach - but where the tone of this organ has been weakened by intemperance - if any acid wine or accecent matter be taken into it - it will not possess the power of changing it into an alkali - but acid properties will be imparted to all the secret - the sweat & urine will each redder litmus paper - In cases of dyspepsia then, there is an increase of acid in the urine generally of the phosph^{ic} & lactic acids. This in young persons will produce the stone & in old persons the Gout. These are in reality the same disease there is no difference in their cause & vary only according to the constitution which is attacked -

What is the Stone? It is an accumulation of lactic acid - lime - phosph^{ic} lime - Mag^a &c &c



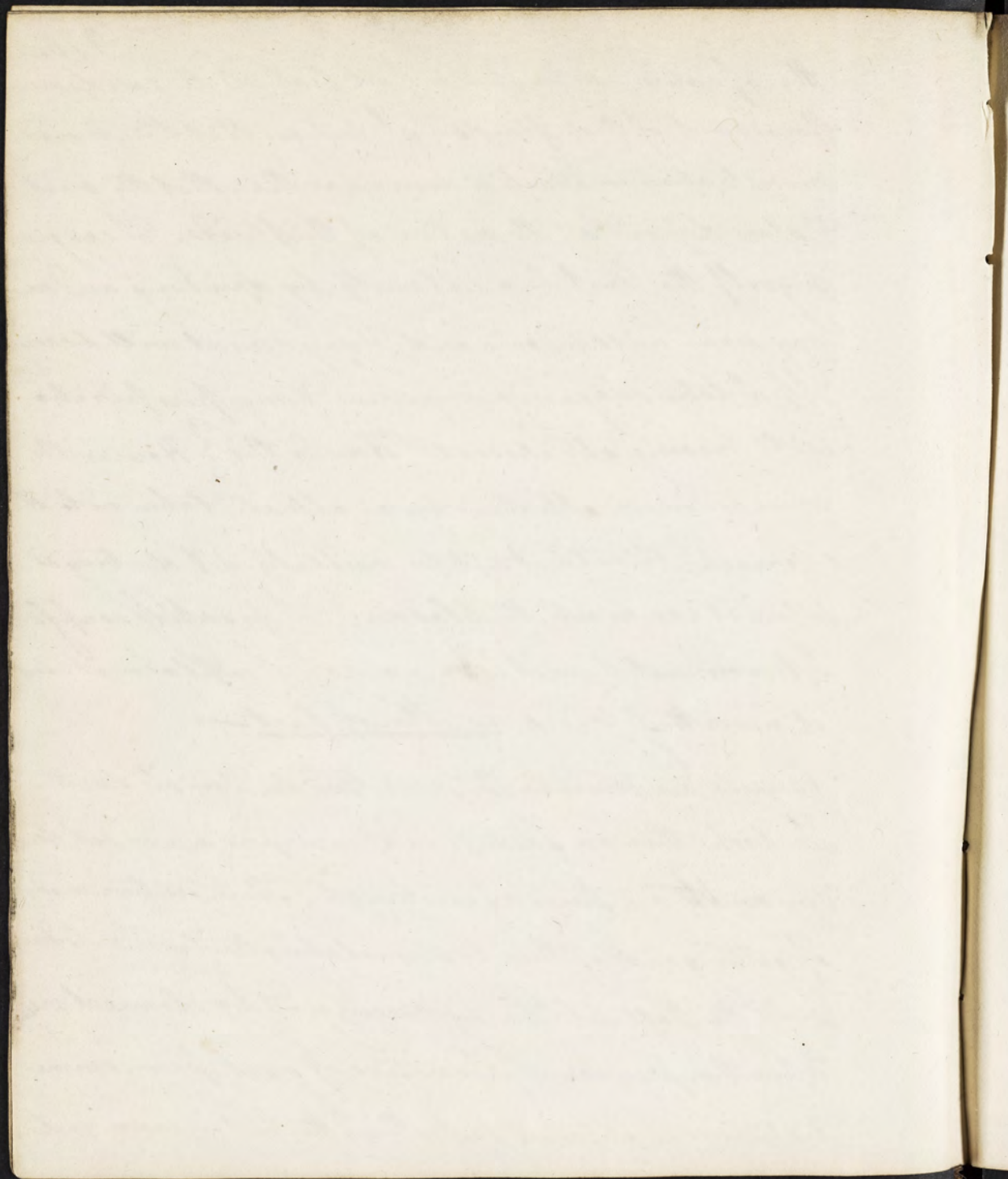
united in layers by albumen & gelatinous. All nephritic complaints generate uric acid - & Lithic Acid - it is now in Gout, concretions are formed in the joints & extremities - which on analysis are found in every case to consist of Lithic Soda - The causes therefore are the same - the concretions are not only apparently - but also chemically the same - & it is utterly impossible that they are the same disease differing only as to the parts affected -

Previously to the time of Hoffman, all physicians accounted for the disease - & for the operation of medicines by the effect produced on the fluids - which were thought to be changed by disease - & could again be changed by medicine - But Hoffman finding that medicine had peculiar properties - thought that the fluids were under the control of the solids - & that medicine acted on the solids - This idea was adopted by Cullen & is now the prevailing sentiment - It is in some measure true - but has been carried much too far - It would be well for its advocates to consider, whether the chemical properties of the fluids are absolutely unwar-



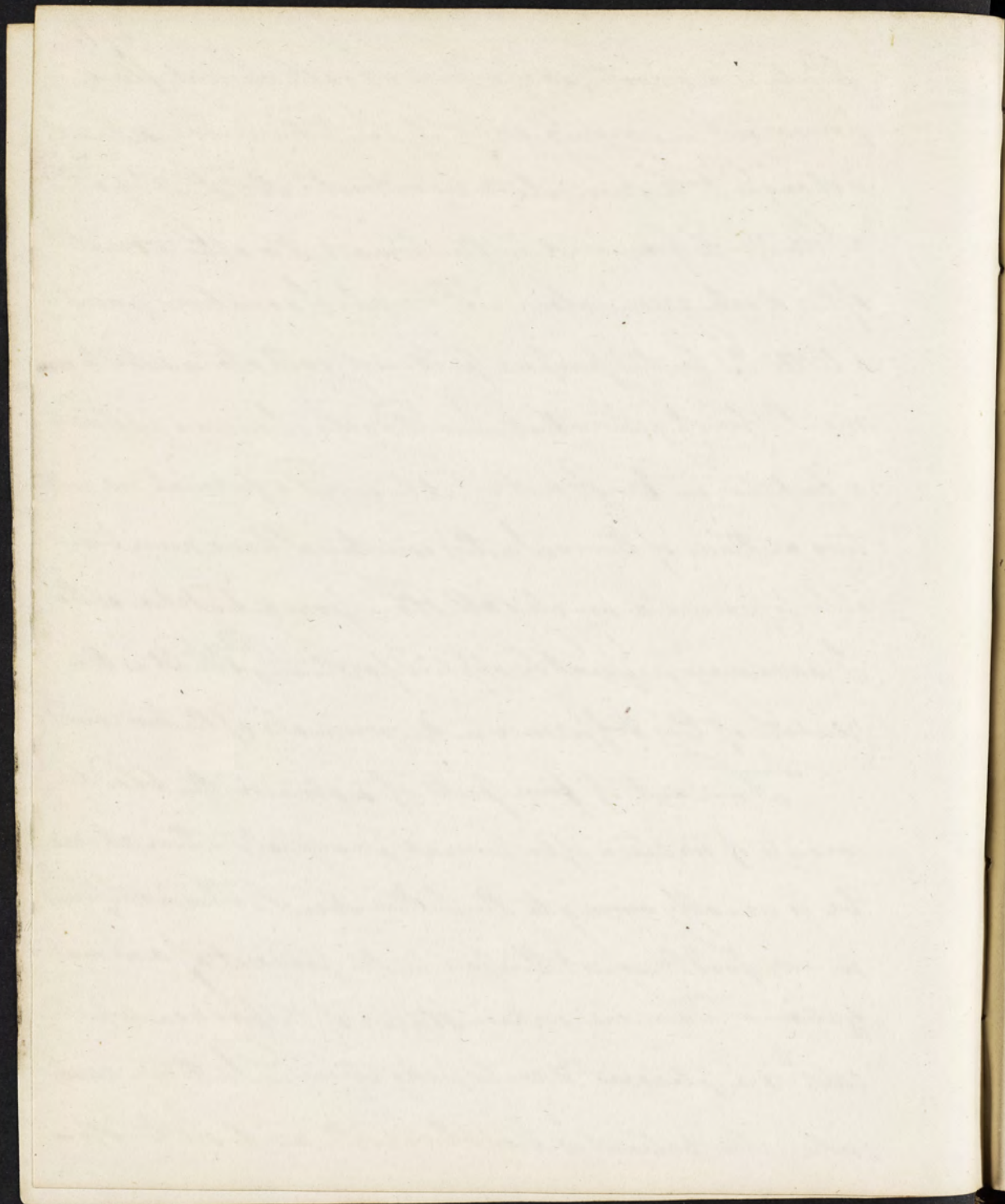
they of notice - when it is a fact that all the solids are
 formed out of these fluids - I believe that there is no de-
 monstrations in Euclid more clear than that the gout
 & stone depend on the nature of the fluids. I can give
 myself the Gout to a certainty - by drinking acid wine
 my urine will become acid - & my sweat will be acid.
 If I take magnesia my urine & my perspiration
 will become alkalizant - How is this? How is the
 wine rendered alkaline by an alkali taken into the
 stomach. Would it not be neutralized - & destroyed
 before it can reach the bladder? I frankly confess
 I know not how it is, nor can I explain it - but
 it nevertheless is a matter of fact -

Calculi are found in the Gall Bladder & in its ducts -
 In books these are said to be of an adipose, waxy substance
 & no doubt are truly characterized. There are two modes
 of getting rid of these by stimulating the liver & its ducts
 with the Gall bladder by mercury - & by chemical means.
 Where their presence is productive of great pain, imme-
 diate ease is obtained by bathing the feet in warm water.



Bile is a smooth, soapy - perhaps alkaliescent fluid, poured out in varying quantities into the duodenum - it is changed to a green colour by vitriolic acid - & by other acids. Hence from acid in the stomach it is often vomited of this dark green colour - Formerly I sometimes painted a little - & for this purpose procured gall stones which gave me the finest yellow that I could get - I never applied to a butcher in Eng^d - but what he would furnish me with two or three of them - In this country I have never been able to procure a single gall stone from a butcher - altho' I have very frequently applied for them. What is the reason of this difference in the animals of the two count^{ies}?

Four out of five parts of a stone in the bladder consists of urates - often several phosphates - their character is usually owing to the Lactic Acid - This is not found in our food - & must therefore be the product of animalization - There are certain states of the body in which cal^{ic} is a pleasant & mild purgative - In those cases where the patient is troubled with acid on the sto-

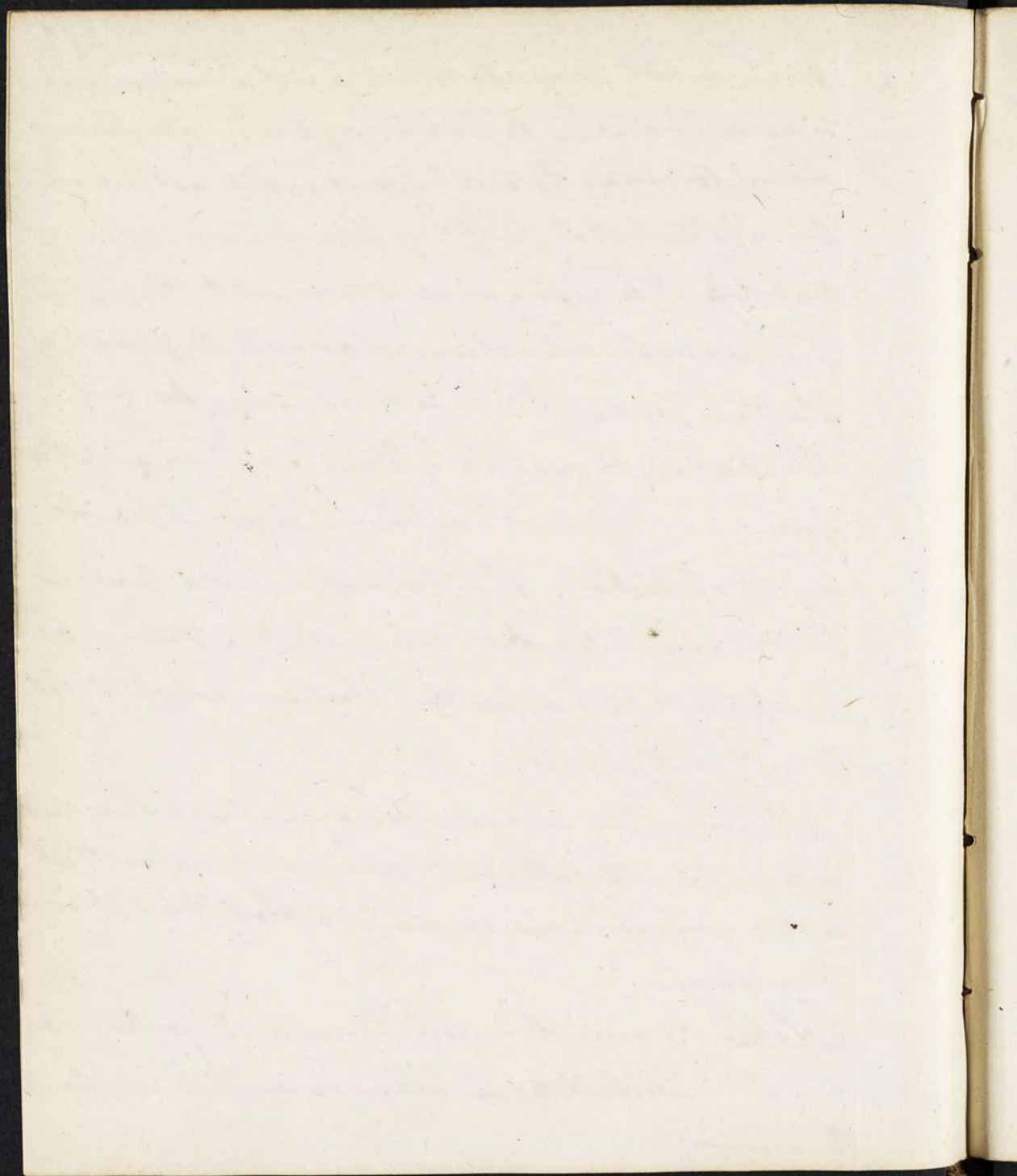


mach or with hemorrhoids, which last I believe owing to a morbid acid in the primæviæ, cal: will produce violent tormina. The actⁿ of mercury will not produce these effects - but the phosphⁿ of mercury always acts very violently. It has often occurred to me, whether the tormina produced by the calomel was not owing to the presence of phosphoric acid. This is however a conjecture only.

To ascertain the quantity of Urea in a given quantity of urine - inspissate it & dissolve it in four times its weight of alcohol: If nitric acid be added the urates will be changed to a pink colour. The phosphates may be separated by heat from the Urates in which the latter will be dissipated.

Albumen This is a common animal substance, it is miscible with cold water & coagulated by hot water; it is the serum which rises in making broth & which is thrown away.

Gelatin - is miscible in cold & soluble in boiling water. It is precipitated by Tannin in the form of leather. —

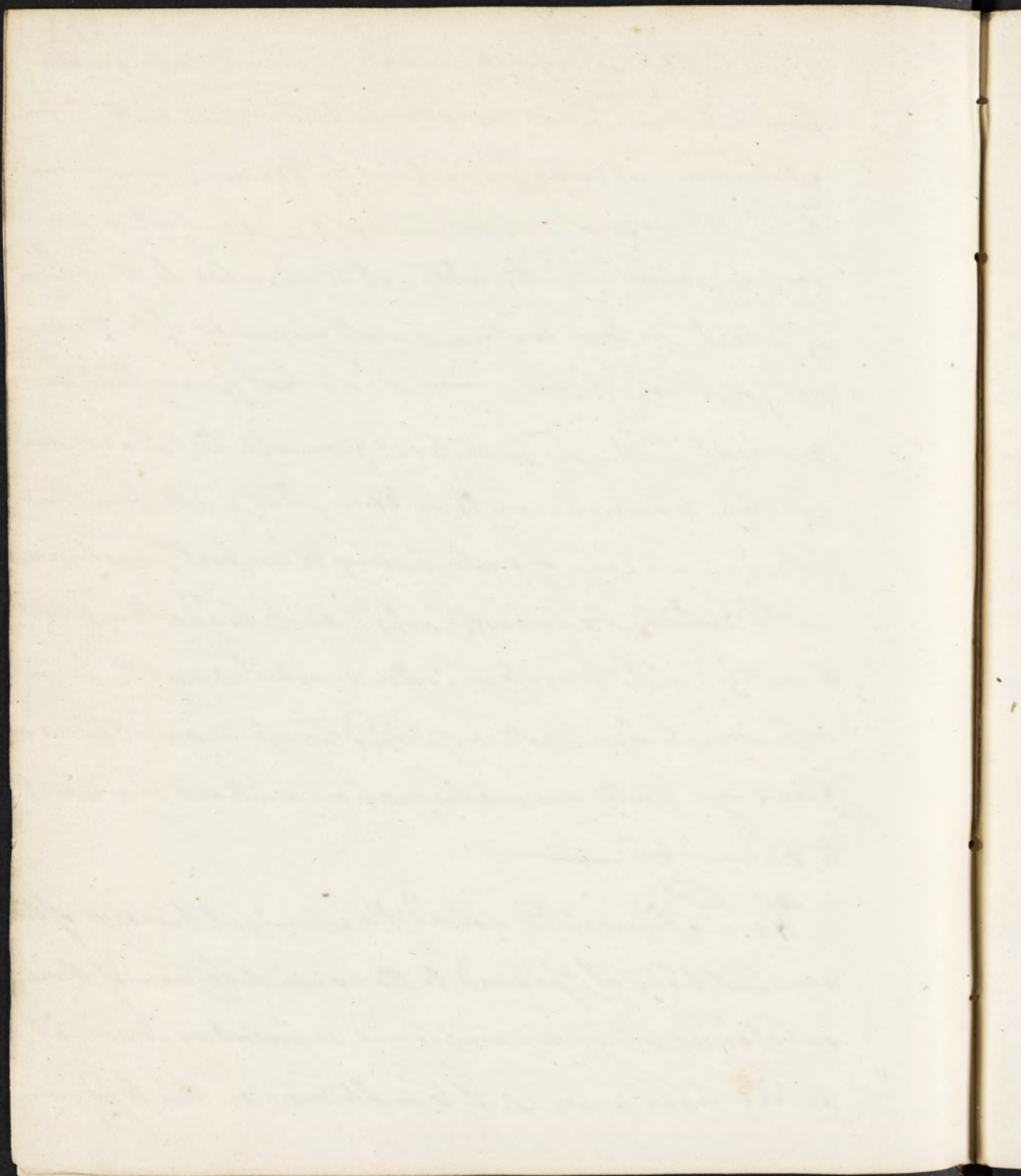


Mucilage - or extractive matter. This is distinguished from albumen in not being coagulated by hot water & from gelatine in not being precipitated by tannin. —

Fibrin - is not soluble in cold water - but is by long digestion in hot water - it is similar to the gluten of wheat. Fibrin contains small quantity of Nitrogen not found in Gluten. — I do not know that any medical fact can be deduced from all that I have said but there is every reason to believe, that ^{there} will find that place in a chain of facts - leading to important conclusions.

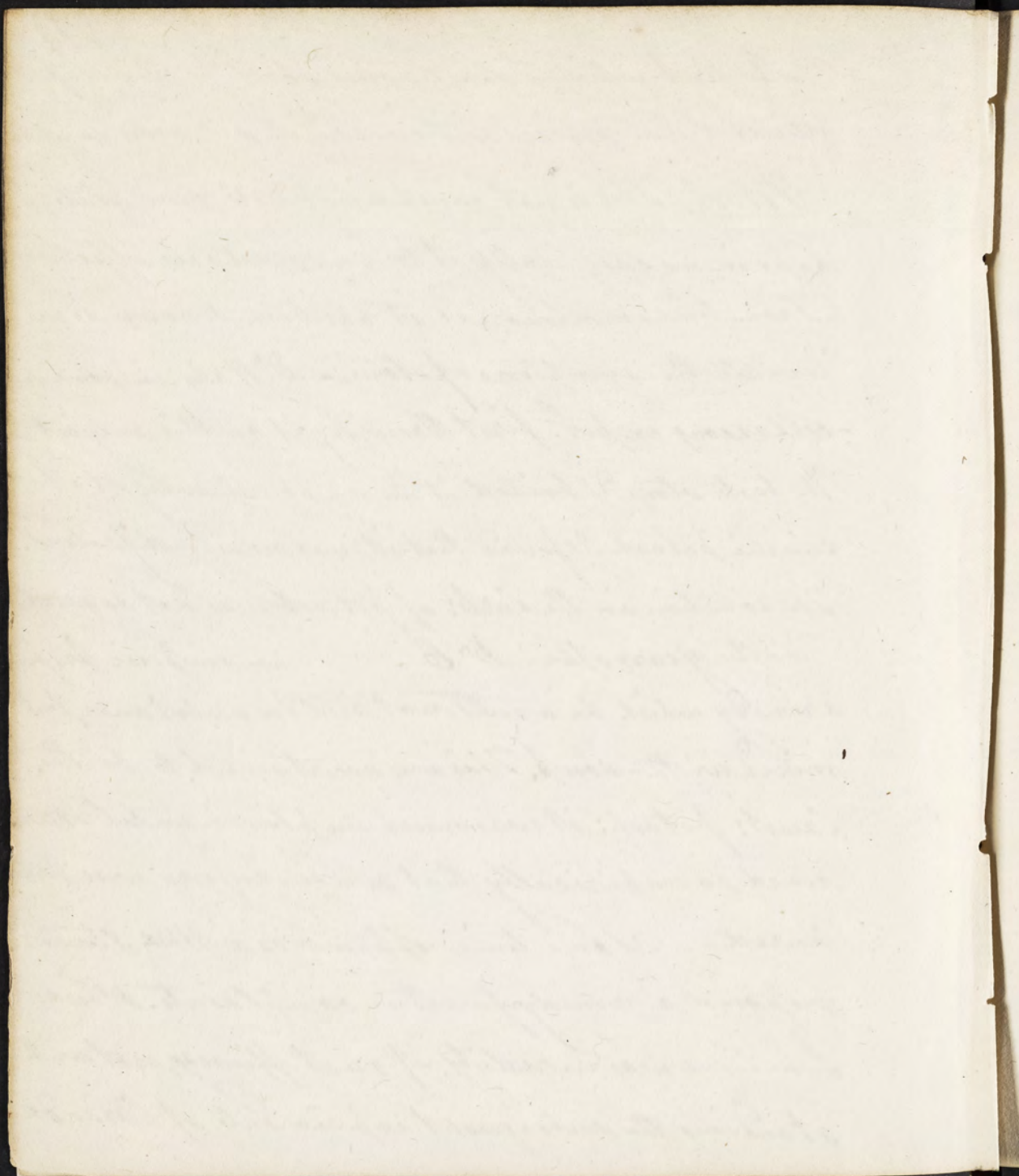
Dr Bostock by Lacroix: Sub: & sect: had attempted to distinguish pus from other morbid secret - Later experiments have not confirmed his opinions. A surgeon's eye will answer his purpose without any resort to Chemistry —

Having thus briefly noticed the chemical history of the animal body - I proceed to the consideration of those substances which are employed as ~~secret~~ medicines & which have more or less influence on this body -



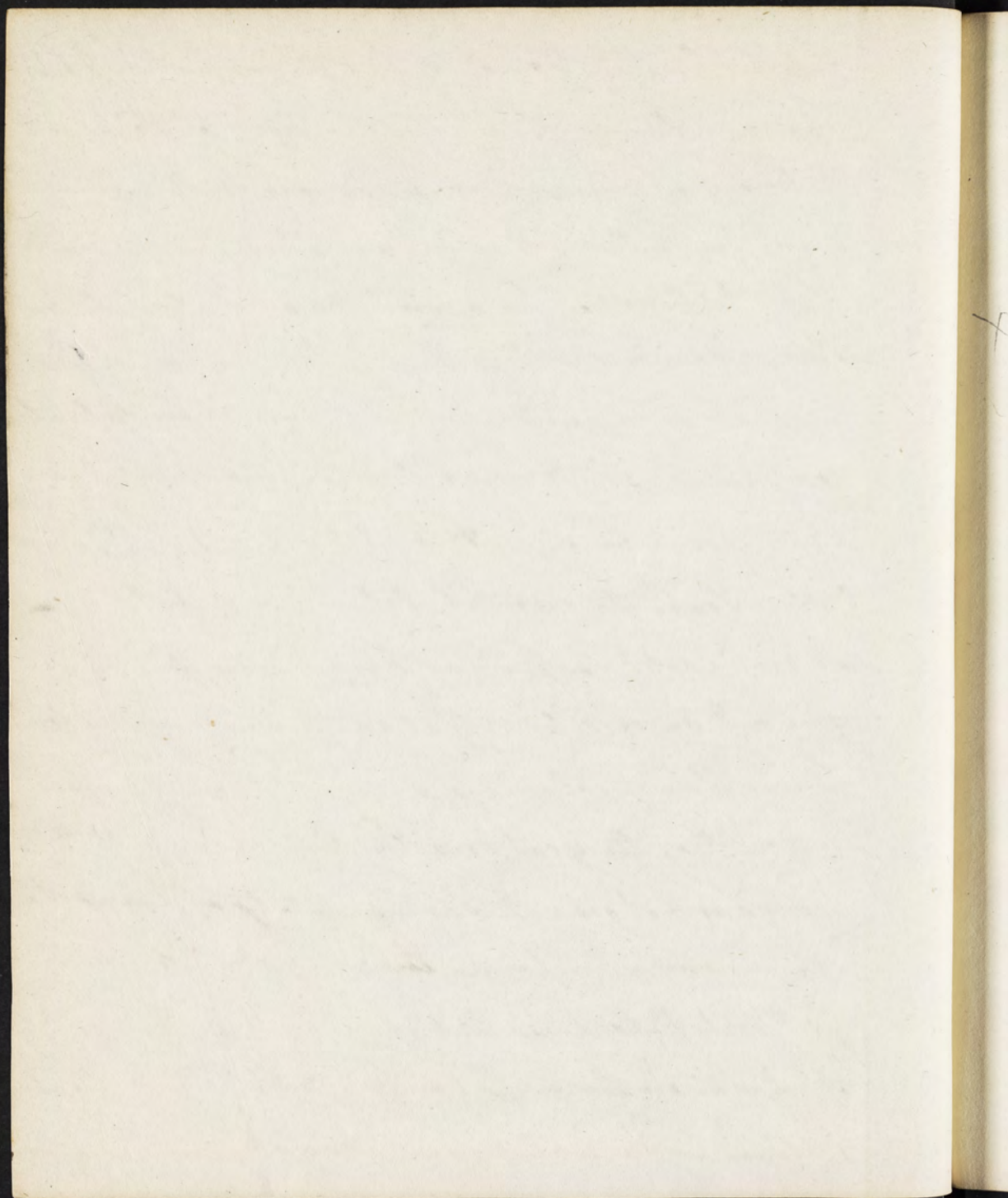
The first which I shall notice shall be the simple articles & then proceed to those which are more complex.

Potash. This is not much used in its pure state, perhaps in no case-unless it be in calculous affections. From time immemorial it has been known to alleviate the symptoms of stone - Dr Hales in some medicinal experiments first threw light on this subject - He took a stone & boiled it in an equal weight of caustic potash - & found that it was nearly dissolved. The solution in the carb: of potash was not so great. Forty years after - Dr C an empiric proposed a remedy which he would not sell in substance, but mixed with soup. This was ascertained to be the caustic potash: it was much employed-until it was used so empirically that serious injury was produced. Some time afterwards a Mrs Stevens proposed a remedy for these complaints. Which I believe was in reality of great efficacy, notwithstanding the subsequent experiments of Brande

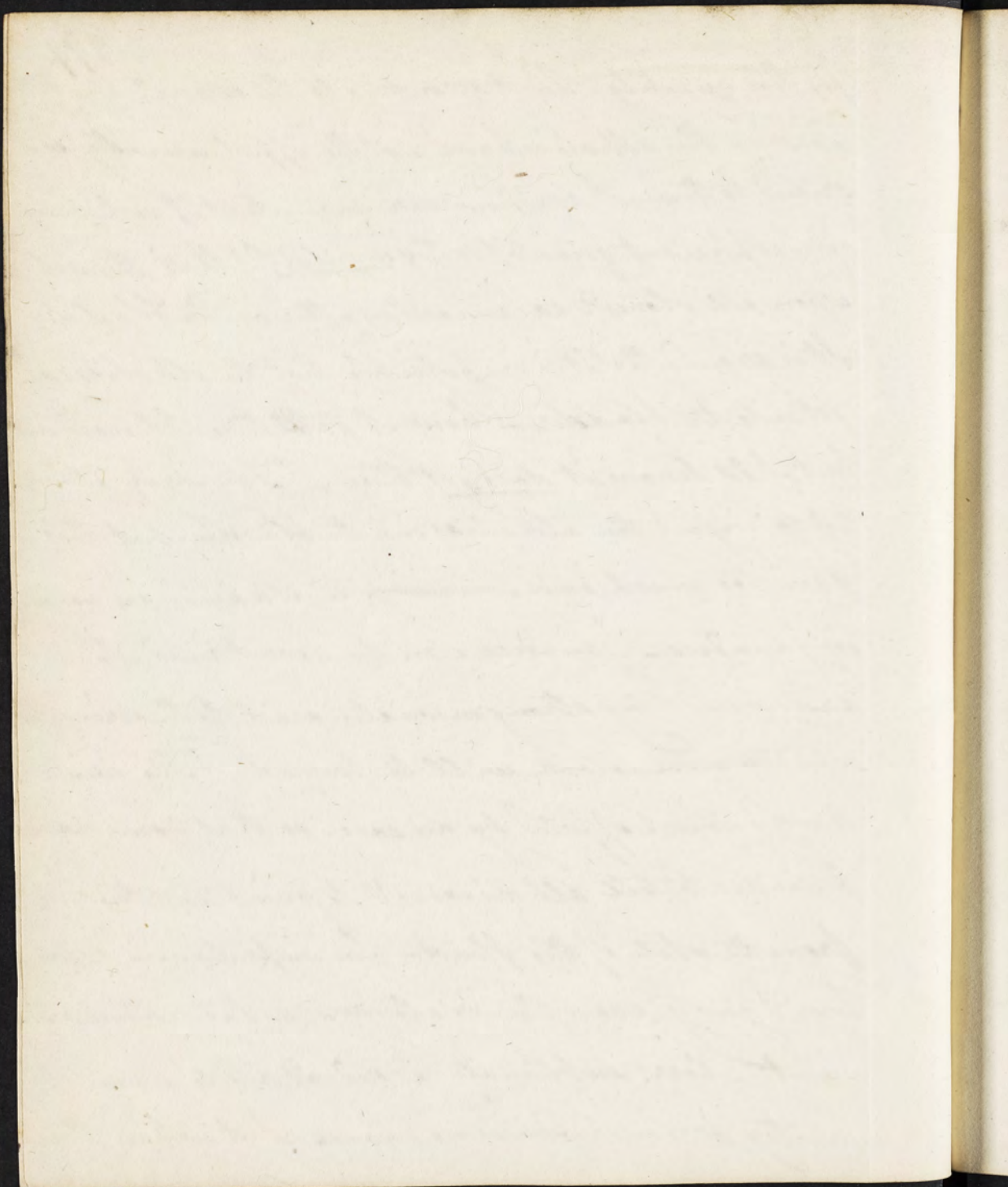


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which I believe do not deserve the confidence generally
reposed in them - It is utterly impossible to have the
testimony of more respectable persons for the efficacy
of any remedy than that which was given for the remedy
of Mrs Stevens. In a work by a Mr Dodds, not
often medically read, there is an incidental mention of
the efficacy of oyster shells & pure potash in calculous
complaints. Mr Key in a tract on deformity bears
a similar testimony. As to Mrs Stevens' remedy with
Castile Soap. The quantity taken is very safe - ʒi
of good Cast^e Soap, a day has no ill effect on di-
gestion & an excellent effect on the gouty symptoms.
I myself have taken ʒss daily. & I have therefore
no doubt of the good done by the remedy of Mrs V.
You cannot give the same quantity of pure pot-
ash in any other form. There is in Castile soap
1/8th part potash - so that in every ʒss - there is ʒss
of potash - in the usual way of exhibiting the al-
kali in Soda waters - you cannot give more than

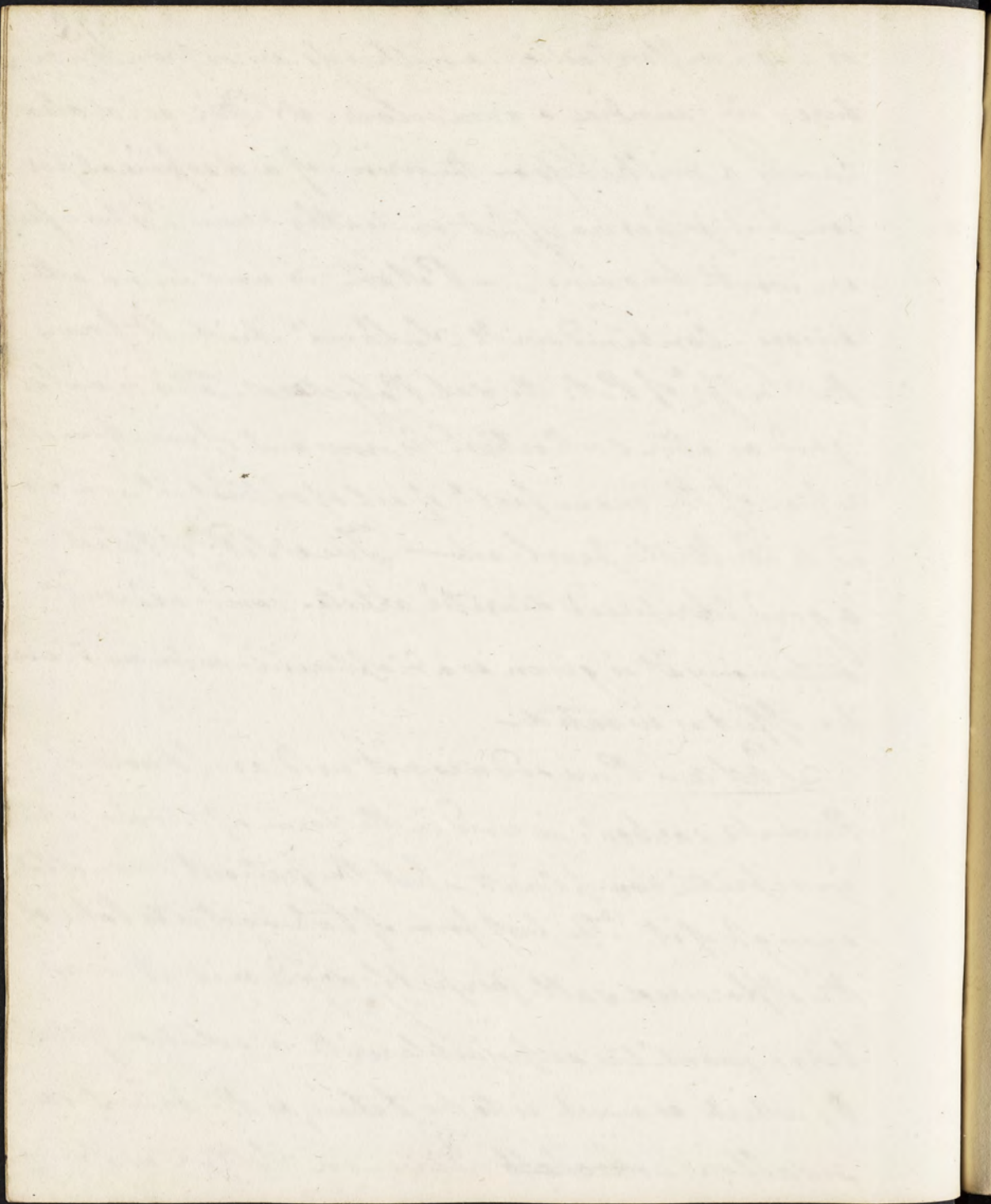


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1/4 this quantity - But according to the experi² of Mr
Brande the alkalies have not the effect usually as-
cribed to them - I am however sure - that if exhibited
in sufficient quantities they would & that they act
upon all stones & calculous matter in the bladder -
It is argued that it is impossible - that the alkalies can
get into the bladder - Now it gets there I know not
but I do know it does get there - Fourcroy attempt-
ed to inject the alkalies into the bladder - but this
gave too much pain - The alkalies are useful
in jaundice - jaundice can be ascertained chemi-
cally - by adding strong muriatic acid to the urine, by
which a green colour will be formed - The urine
is very much affected by disease - so that some have
pretended to tell all diseases & to point out the cure
from the state of this fluid - In nephritis - in calcul-
lous & gouty cases, there is always a latritious sedi-
ment - Corr: sublimate added ~~added~~ to urine of
healthy person produces no change - but where there



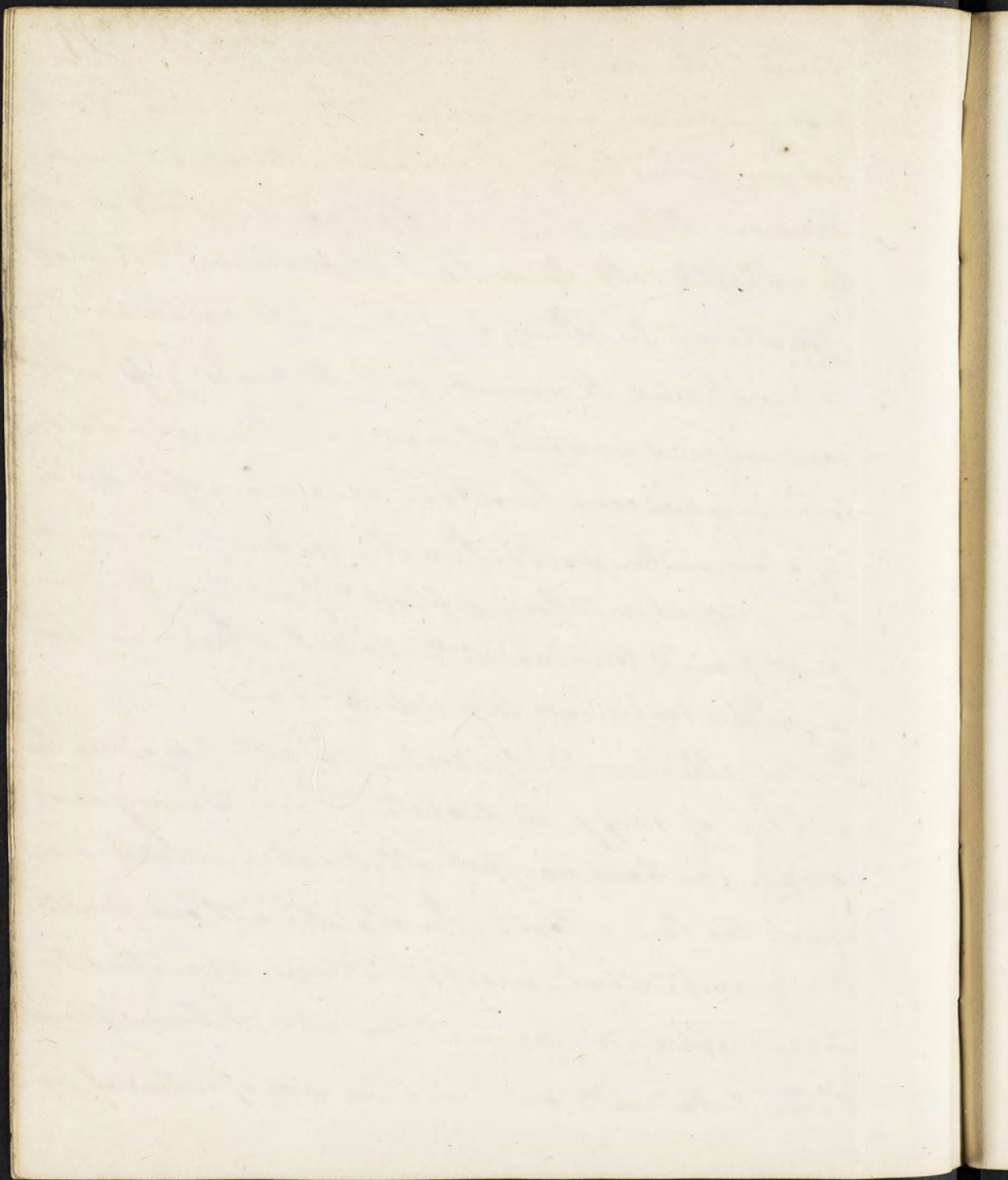
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is high in inflammation - a milkiness arises from the mixture - in jaundice a green colour - & this acid also causes a milkiness in the urine of a dropical person but has no effect on healthy urine These facts are worth knowing - Potash is used in no other disease - Combined with Sulphuric acid - it forms the Sulph: of Pot: the sal Polychrest. This is not so good as other cathartics - It is now out of use - being the refuse of the manufact^r of oil of vitriol it is employ^d to adulterate pearl-ash - The Vit^r of Potash - is a good febrifuge & diuretic article - combined with antimony it is given as a diaphoretic - when no diuretic effect is wanted -

Soda - Pure soda is not used as I know of - the sub: carbon^t is used in the form of Soda pills in repletive complaints - but the patient cannot take enough of it. The best form of taking it is to take of the effloresced salt - perfectly dry - & mix it in as large quantities as possible with a solution of soap. Of which as much is to be taken, as the patient can swallow - ~~And~~ Given in Seltzer water &c



cannot take enough - The Sulph^r Soda is the ²⁷⁹⁸re-
fuse of so many manufactures - that ^{it} is very cheap - & is there-
fore much employed - It is a good cathartic - but is very
nauseous - this is best covered by lemonade - But of all
the cathartic salts - the mildest the pleasantest & the most
efficacious is the Phosph^r of Soda - It is made by adding
the phosph^r acid to common salt - the dose is ʒijss - Inst^s.
have occurred in which it exacerbates hemorrhoidal symp-
toms - in which cases I would be as cautious of its use as
of aloe - neither would I use it when more is given as
it - I suspect, will form a phosph^r of mercury - producing
great pain & tormina in the bowels - I have not had
sufficient experience to decide this point -

The alkaline Sulphurets - Balle has given them
in doses of grs. xx. in diabetes - This is a mere farse -
grs. xx. can have no effect - all English practice is on
much too low a tone? In diabetes - all our practice
is very empirical - vegetables & astringent matters &
warm alkalies & animal food should be employed.
The Sulphurets are useful in cases of mineral poi-

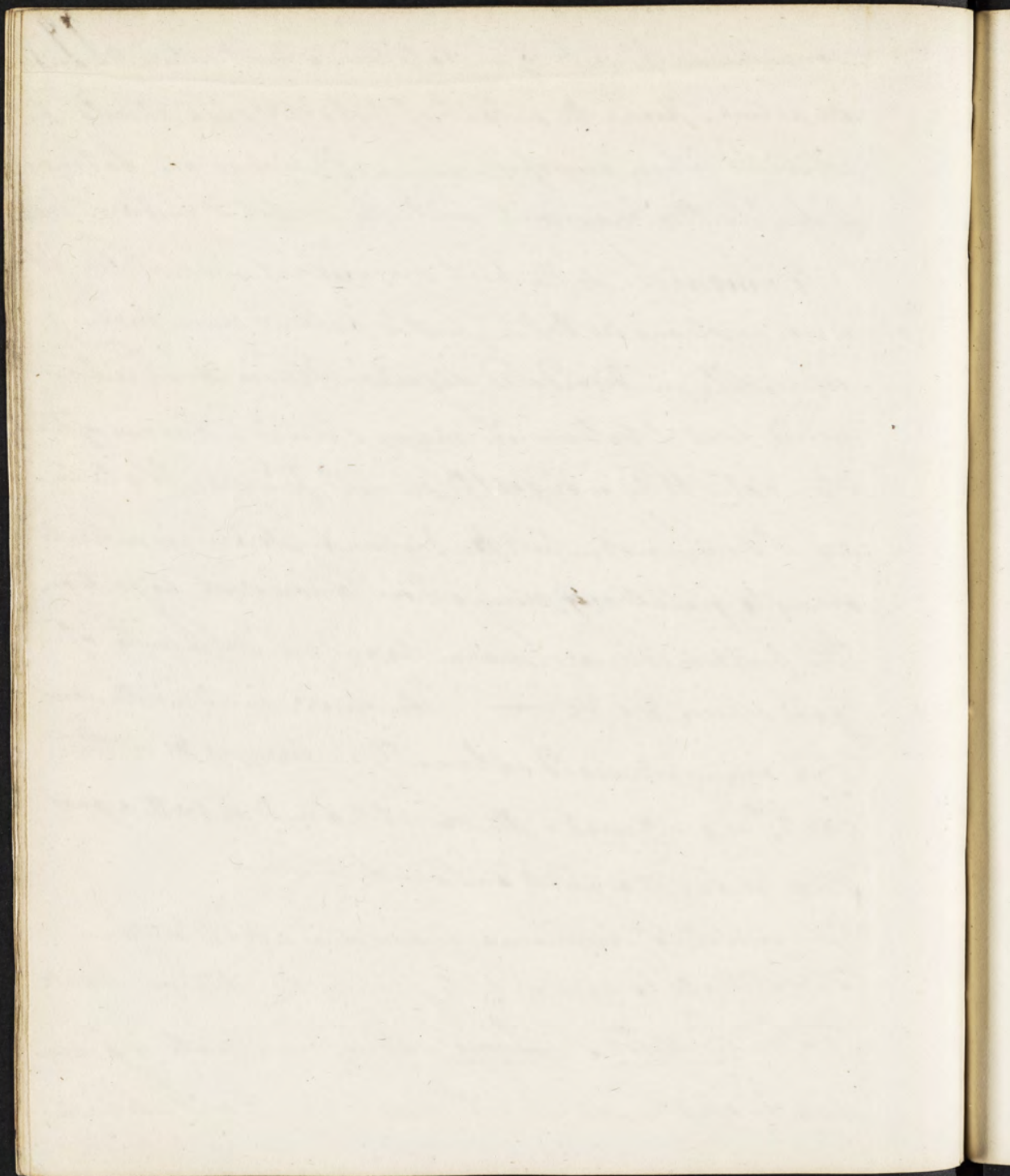


sons - the sulphurets of metals being inert where the acids are active. Hence the sulph^r of potash & soda should be exhibited when any of the mineral poisons are taken as probably they may unite with the metal & render it inert.

Ammonia is the best stimulant we possess it is not so strong as Ether - but is better & more lasting, especially in disordered digestion - & in Hysteritis - which last I believe in many cases is a disease of the stomach. Why indigestion should produce flatulency I know not - but the Globus Hystericus is entirely owing to flatulency, arising from disordered digestion. The best remedies are warm br and y with plenty of good spices - &c &c — The med^{ca}: am^{ca} is the com^{mon} sal ammo^{nia} is used externally in bruises &c - the carb^{on}: is gen^{erally} used - the caust^{ic} am^{monia} is both a good stimulant & a good antacid —

The acetate of Ammonia is used as a diaphoretic - The citrate is used only to procure the vitrous Oxide.

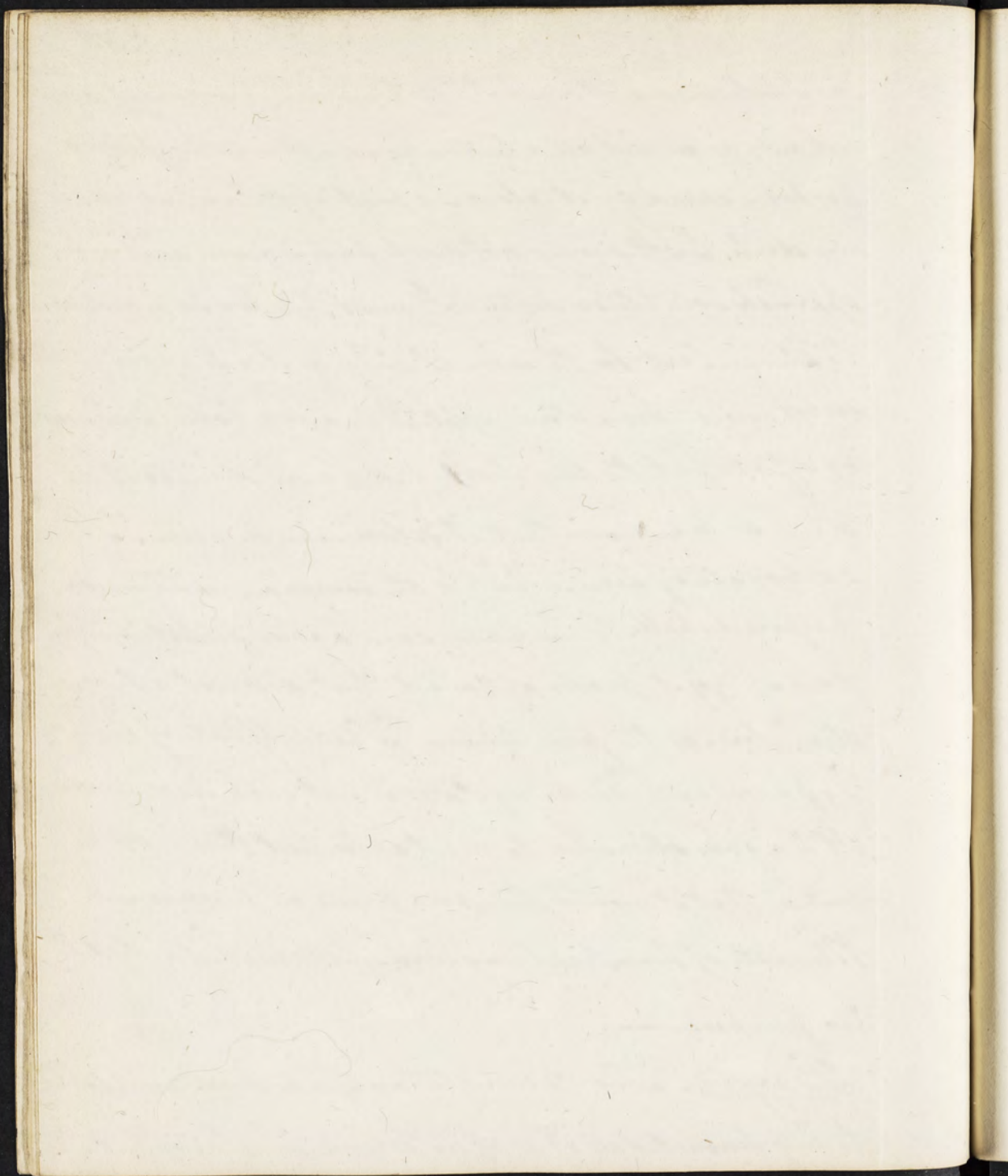
The Earths. Lime - When an alkali is given in a dyspeptic case it acts merely as antacid - having



as I believe, no other effect - when lime is given it acts not only as an ant acid but also as a tonic - Dyspepsia has been cured by it alone - a pint of the water being given daily. In this way not much lime is given, as it is but sparingly soluble in water - It must therefore be peculiarly stimulant to the animal body, as it is to vegetable substances - lime stone applied to a vegetable produces no effect - but the lime itself proves very stimulant -

It is so nauseous, that it seldom can be given. The carbonate of lime, which is the common whitening or prepared chalk is in many cases a good substitute in doses of ℥ij it proves ant acid but does not act as a stimulant - as the pure lime - The sulphate of lime Gypsum or Plaster of Paris is not used in medicine. It is a good stimulant to vegetables but there is no arguing - that it would therefore prove so to animals. Muriate of lime has been given in Scrophula but to no purpose. -

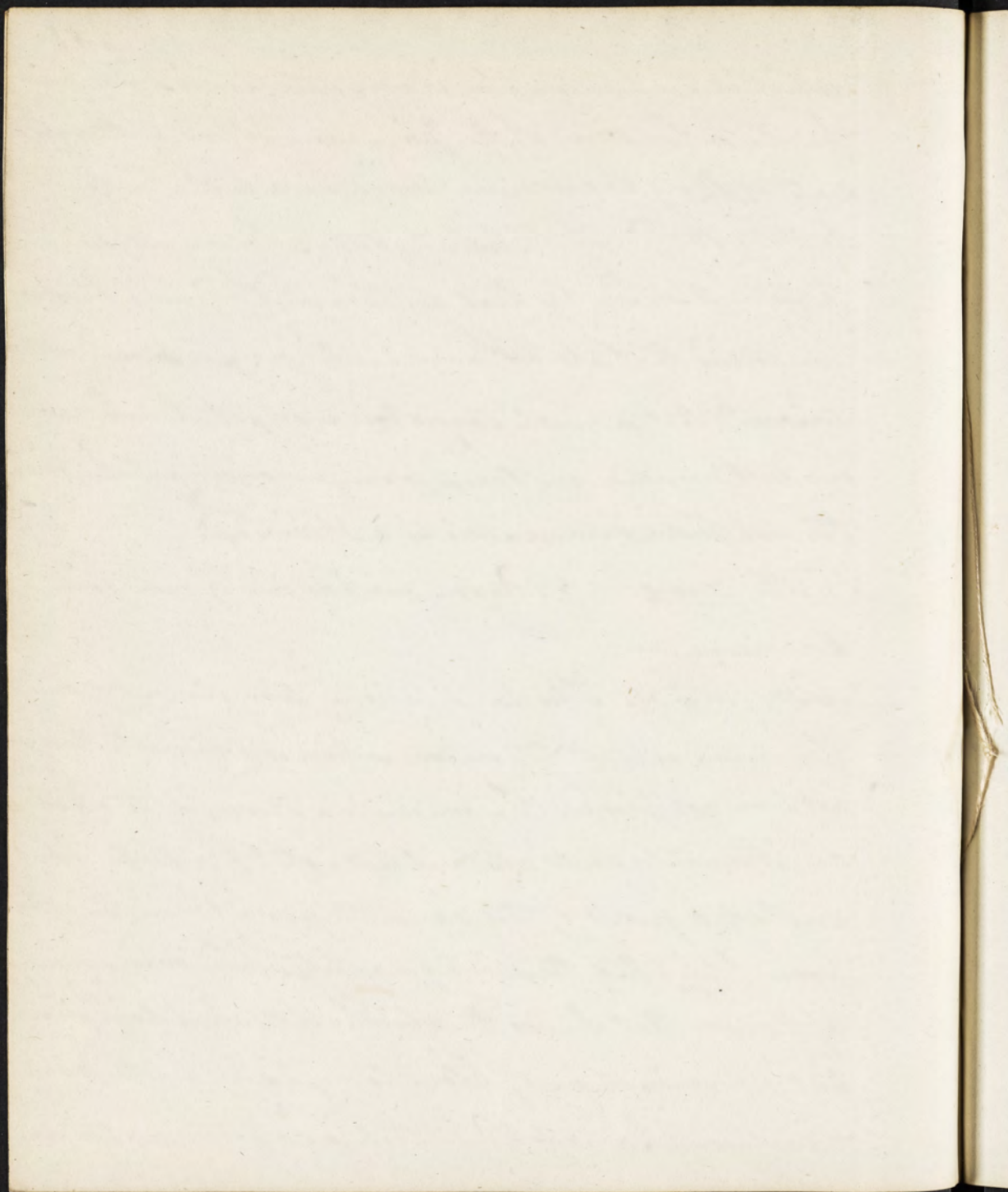
Barytes. The muriate only has been employed - to my knowledge it is of no service in Scrophula, in



which it has been employed very extensively. The first public intimation of the poisonous effects of the carbonate of Barytes was given by me, in a letter addressed to Mr W of Birmingham. In numerous experiments made by that gentleman & myself and others we found that almost invariably grs. & v. proved deleterious & that a much larger dose was fatal. Hence, as our best remedies are taken from poisonous articles, may this not prove serviceable as a medicine?

The Gases. Nitrogen gas has never been given as a medicine. —

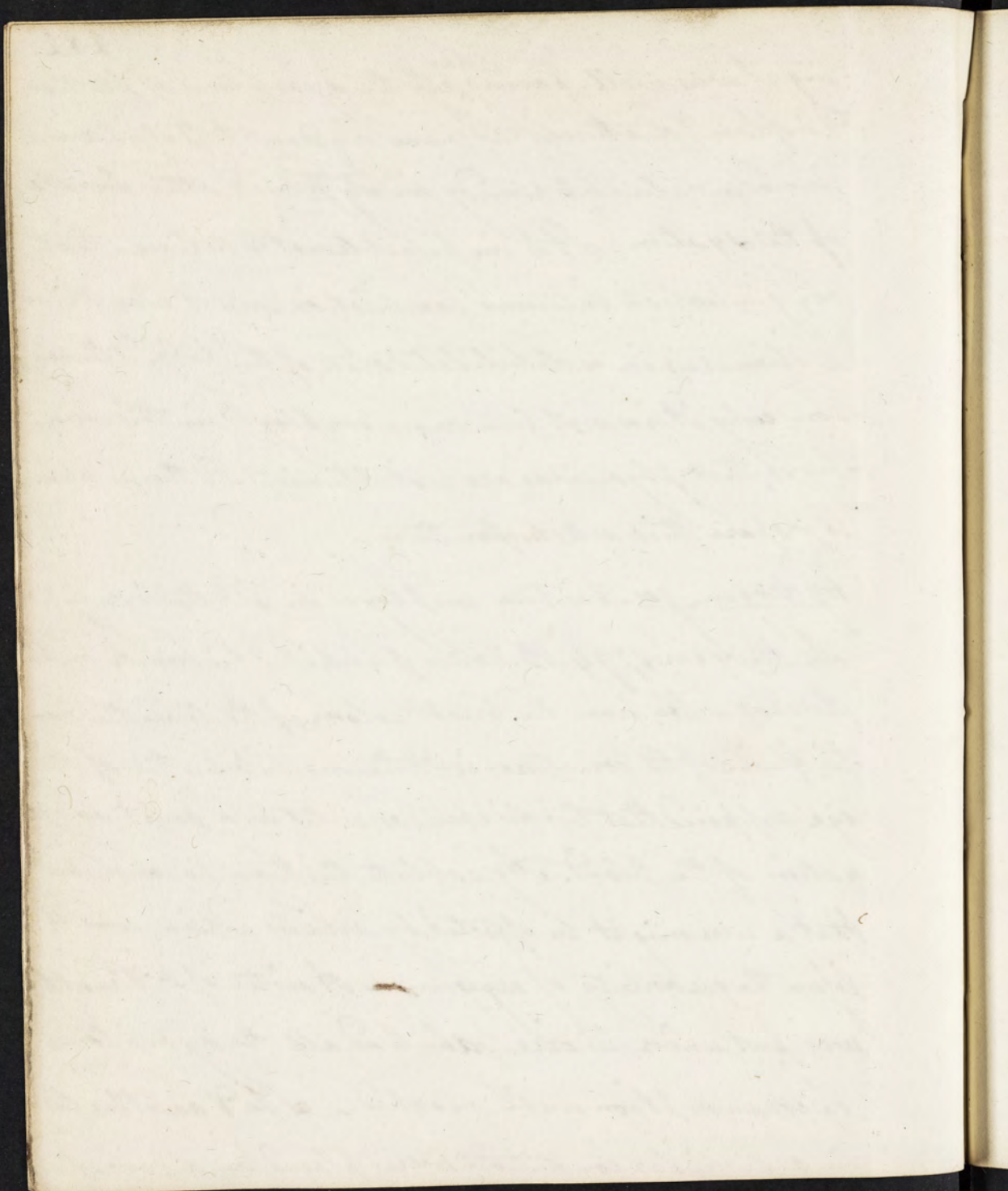
Oxygen Gas. This has I believe, been given by one Physician only, Dr Thomson whose experiments have not been confirmed. If oxygen is a stimulus to a sensible, it must be so to animal life. At Carlisle I once breathed 6 quarts of this gas in the morning & in the afternoon I breathed the same quantity. The consequence of this was that I was threatened with a ^{bad} apoplexy, violent determination of blood to my head with pain & vertigo. I was bled & took a cathartic, next morn.



-ing I was well - having ^{had} all the symptoms of plethora
 & inflam^y diathesis. I have no doubt that it would
 prove a valuable remedy in Typhus & other low states
 of the system. It is impossible not to believe - that
 oxygen which enlivens combustion must also prove
 a stimulus in a debilitated state of the body. & the rea-
 -son, why it has not been more employed in this coun-
 -try is, that physicians are not Chemists - & there is no one
 to prepare these articles for them.

Hydrogen gas has been employed in Phthisis only -

In the year 1794. Biddals published his ~~work~~ on this
 disease - He from the bright colour of the lips - the ro-
 -tic flush - of the countenance - & the morbid lustre of the
 eye supposed that this disease consisted in a sup^r oxyge-
 nation of the blood. Agreeably to this theory he concluded
 that a cure might be effected by articles which would
 lessen the quantity of oxygen. A sister of Dr Priestly
 was put under his care, she had all the symptoms
 of consumption well marked - She & another lady
 in a similar condition were placed in a cow stable



The companion soon becoming tired left it in a few weeks & not long afterwards died - D.P.'s sister remained for 3 or 4 months as required - I was finally dismissed with all her symptoms dissipated. She continued well for about 12 months - when the disease returned & she died - M.W. of Birmingham upon the same principle exhibited Hydrogen to his daughter in consumption. He administered Hydro- to $\frac{3}{4}$ the common air; & always with an evident palliation of the symptoms. She however died. It has been tried in many other cases, it palliates but it never cures.

Carbonic Acid. This gas is never given as a medicine. When breathed it produces a violent oppression & almost instant suffocation, the person falling down as if dead - If fresh pure air is soon administered they often recover.

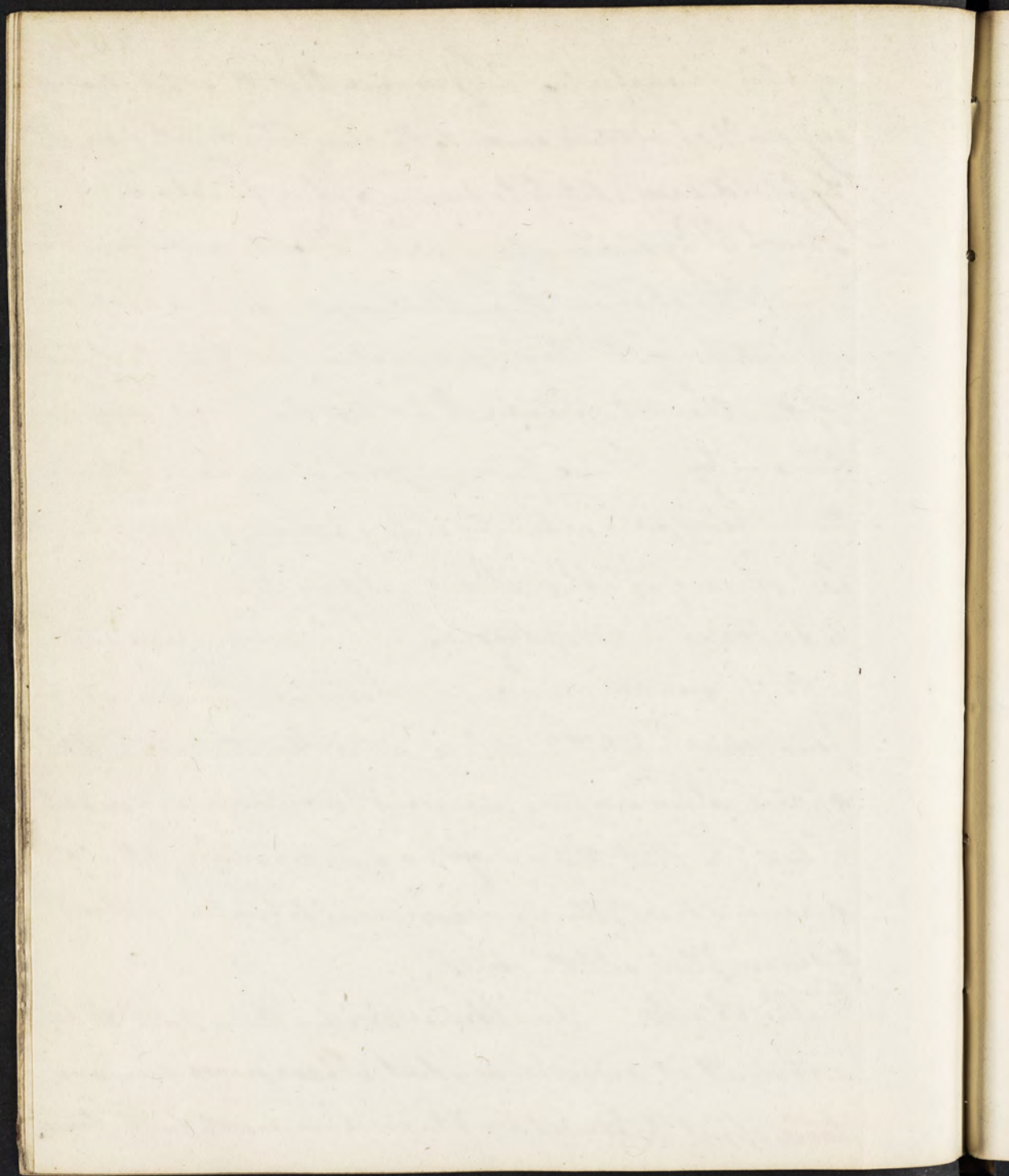
The & Brown oxide gas - This is well known, as a powerful stimulant. It has the peculiarity of never being followed by the debility succeeding these

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of other stimulants. I presume that the exhibition of any gen^l of nitrous oxide to be clearly indicated in all typhoid cases. & likely to prove very beneficial. The French Physicians have given Phosphorus in such cases. This is the strongest stimulant we possess - $\frac{1}{2}$ gr. is rubbed up with honey - this produces a violent heat & all the effects of the strongest stimuli. It has not been much used in this country - I have prepared for a physician in Wartham, Ireland who exhibited it to a patient who was in the last stage of Typhus, it did not save him.

Sulphuretted Hydrogen. Springs impregnated with this gas are universally reported to. They are to be found near Norfolk & Carlisle in this State & also in Virginia. They are very nauseous & very how disagreeable. I believe that they are of no use whatever, & that the circumstances attending excursions to watering places & accomplish all the cure.

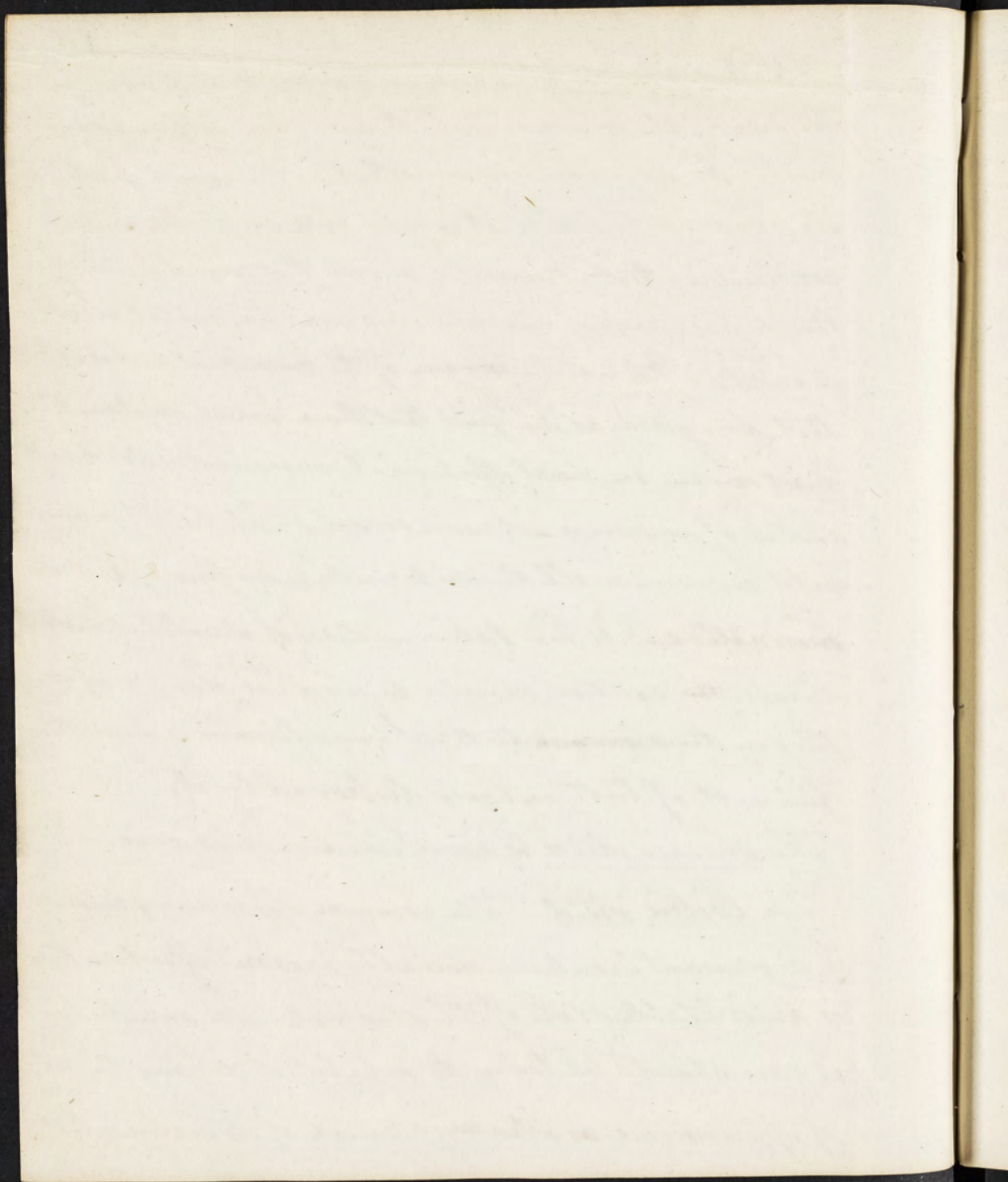
The Acids. Sulphuric Acid - this is said to be a tonic & it may be so - but I have never seen any tonic effect produced by it - we have much better tonics.



Vitric Acid. This was introduced as a cure for the venereal by a man who thought himself a good chemist - His supposition was that as this acid parts with its oxygen very easily - it would cure syphilis; wisely concluding, that it was the oxygen that was effectual in the preparations of mercury - because the metal itself is inert. It is not the oxygen of the mercurial preparation that does good, as we find that those which contain the most oxygen are least effectual - & consequently Vitric Acid is of no service - it never cured syphilis. It may assist mercury - as all the acids render every form of mercury more active - When taken in cases of debilitated stomachs - the caution should be used - ^{there is} danger of acting on the ~~stomach~~ teeth I have known a beautiful set of teeth entirely destroyed by it.

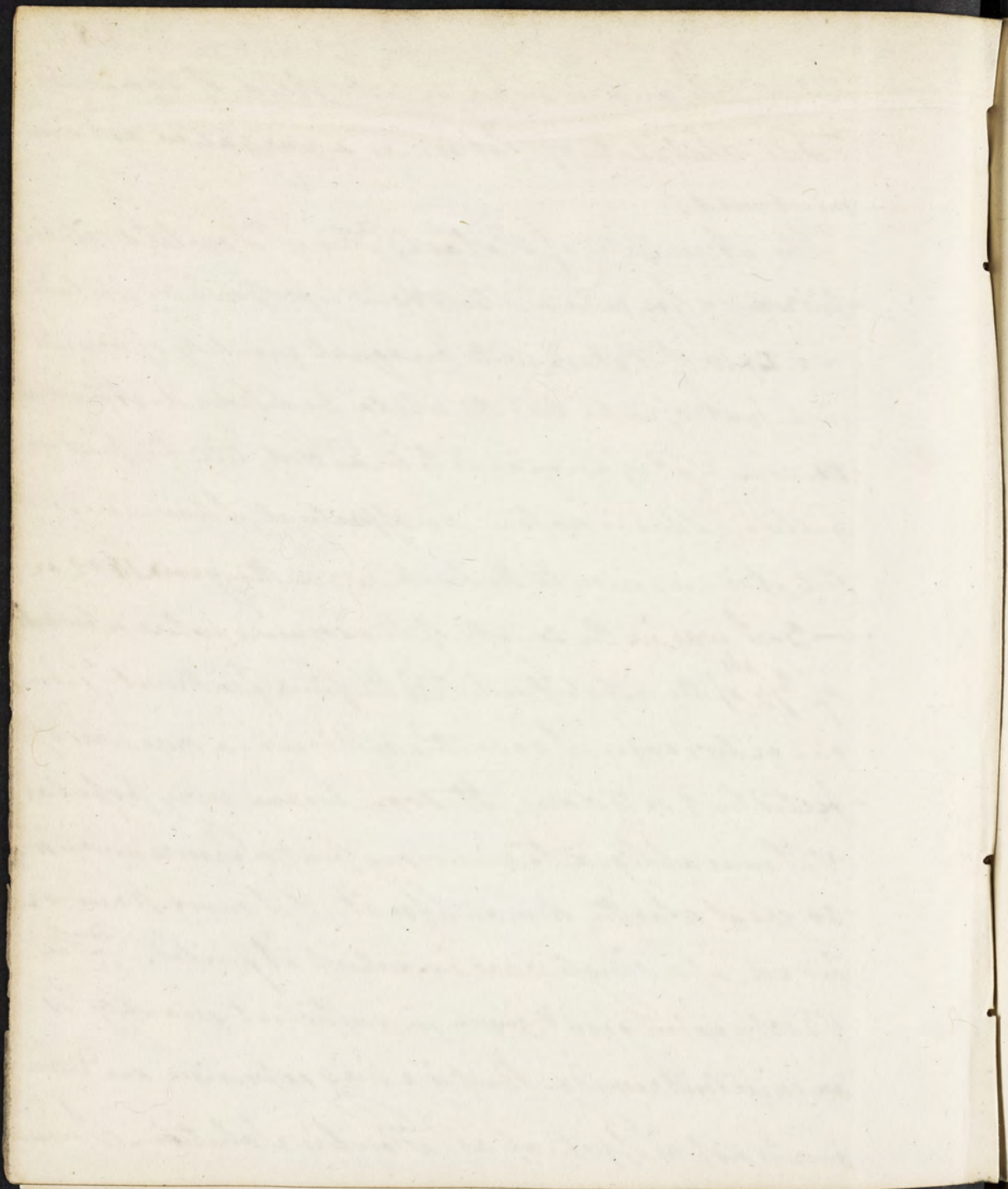
The Arsenic Acid is never used in medicine -

The Citric Acid - The common effereencing mixture is a pleasant laxative - usually prescribed where there is an irritable state of the stomach. In exhibiting it care should be taken to exhibit it during the act of effereence as otherwise much of its virtue is lost -



The Citric acid is superior to the Acid of Tamarind.
 The Sulphate of Potash is a purgative not now
 much used.

The Arreniate of Potash. This is Fowler's celebra-
 ted remedy for intermittents &c. It is prepared by boiling
 grs. xxv of Potash with an equal quantity of Arrenic
 in a pint of water, till the whole be dissolved. After which
 the same ss^{d} of Lavender is to be added, till the pint is
 filled. There is no tonic, so effectual, I have no doubt
 that it is superior to the bark. In the year 1802 or
 -3 I was in the County of Wyoming where upwards
 of $\frac{2}{3}$ of the inhabitants had the fever & intermit^{ts} - in
 one or two cases I gave this medicine a cure was ef-
 fected by 2 or 3 doses. It soon became very popular
 & I was obliged to renew my pint measure every way
 so great was the demand for it. I never knew or
 heard of a single case in which it failed. The
 Bark when good & given in sufficient quantity is
 an excellent remedy. But is a very expensive one & more-
 over is not as effectual as Fowler's Solution. I usu-

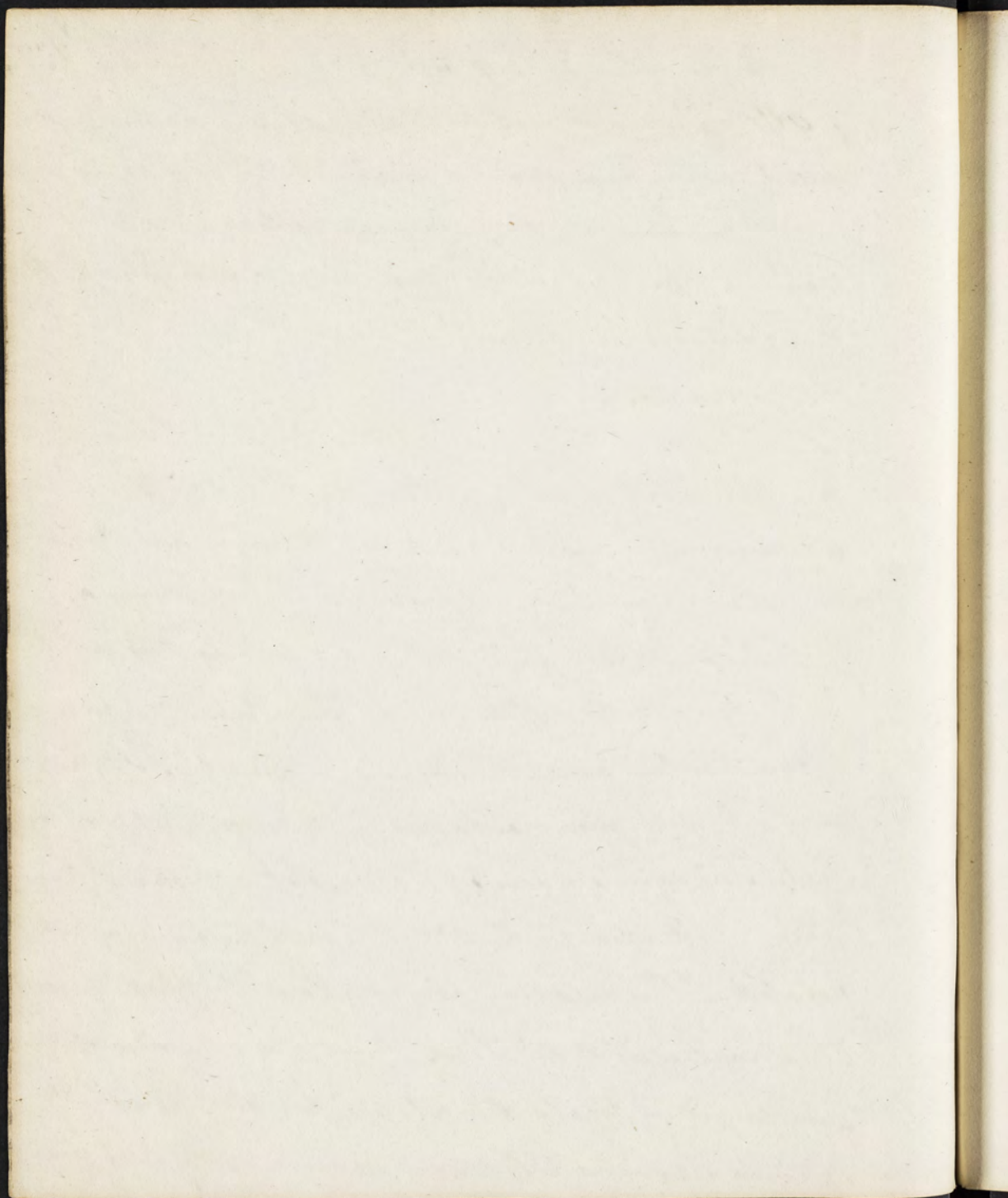


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-ally begin with grs. vj twice a Day. Increase to viij
x grs. You may venture to give it till nausea is pro-
duced when you should diminish the dose, as this will
always be too great - when nausea follows its exhibition
it causes indirect debility - thus counteracting itself. It
should therefore be given in the largest dose without ex-
citing nausea.

The Phosphate of Soda is the best - the best tasted & the
most pleasant of all the cathartics. It is contraindica-
ted where there are piles & where mercury has been given
as in these cases likely to produce violent tormina.

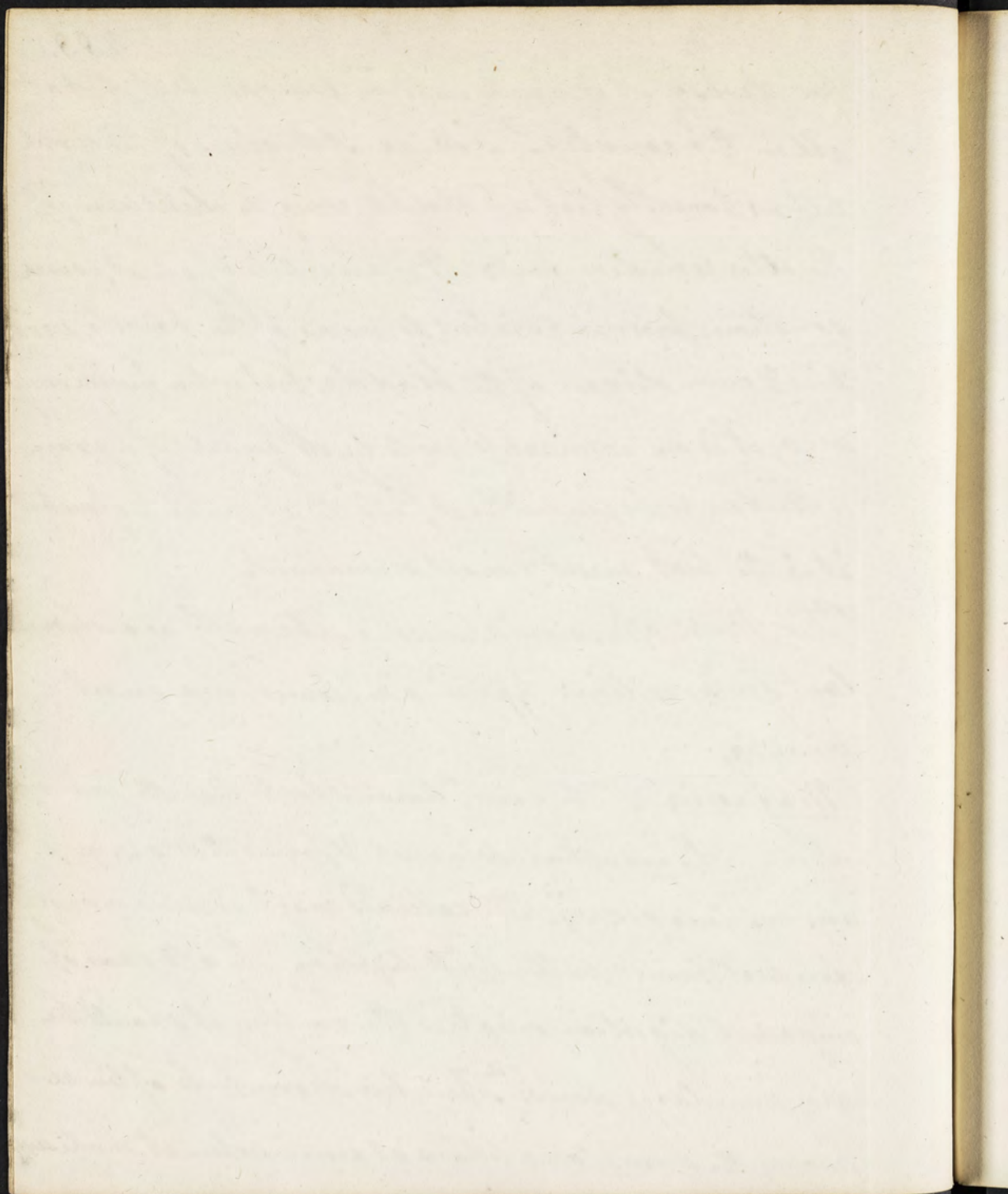
The Tartrates. All of them are bad as they are like-
ly to increase the Uric Acid. The Super Tartrate of
Potash has been much in vogue as a diuretic. Ferriar
has published numerous cases of its successful employ-
ment. His cases are generally well related & some of them
which I attended with Dr Ferriar I know are truly
related - This medicine however loses its effect & should
be alternated with digitalis. Digitalis should not how-
ever be given to old debilitated persons. Cal^l &
squills are good - Clatorem is however the best remedy



for dropsy. It is much used in Europe but not at all in this country. Ferriar at the close of his work tell us honestly, that we should recur to clatruum, if the other remedies fail. It is an article of great power sometimes producing violent tormina of the bowels, vomiting & even disease of the bladder: but when judiciously used, it is an admirable remedy. A quarter of a grain is the dose to begin with. Of all the wacuoants of water it is the best, surest, & most permanent.

The Mur: Ammonia is used externally as a stimulant embrocation: Zj being dissolved in a quart of vinegar.

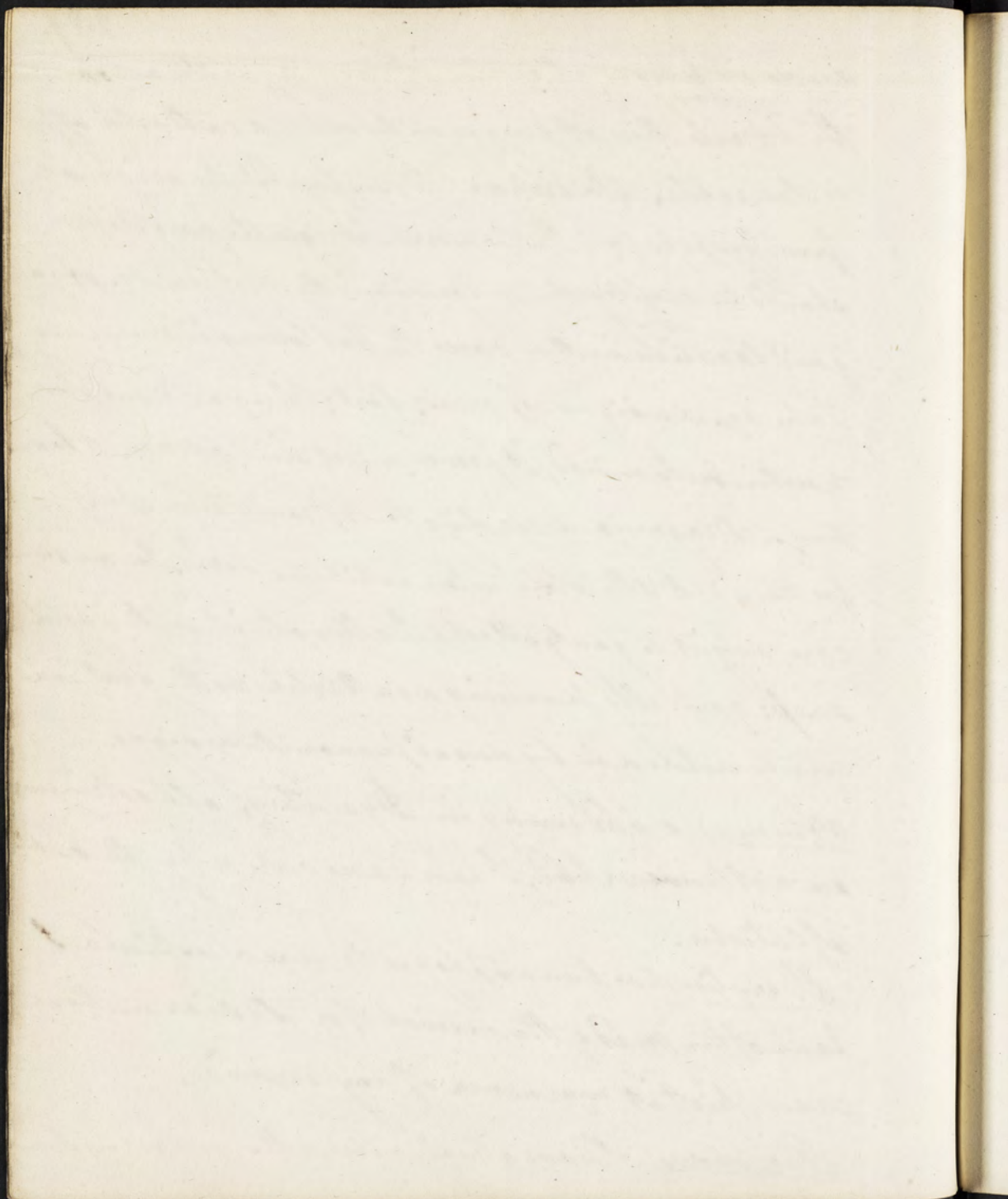
Magnesia. The carb: ^l has less taste than the pure magnesia. I have often calcined it & found that gro. x always loses gro. viij. The calcined mag^a is more nauseous but mixes better with liquids. In all cases of impaired digestion mag^a is the remedy - it should be given in large doses: Three tea spoonfuls often removes the symptoms like a charm - when it meets with



acids it purges, otherwise it has very little action on the bowels thus it purges only where a cathartic effect is desirable. Diarrhoea, Dysentery, Piles originate from Dyspepsia. In hemorrhoids gentle purgatives should be employed - magnesia is the best remedy. As a good laxative in these cases the following is much used. Take equal weights - of cream: tart: Sugar & sulphur & when duly mixed, it proves a certain & pleasant laxative - Magnesia according to Bronde is a specific for the gout & the stone when exhibited early. In my own case subject to gouty attacks, I alternate it with castile soap: generally promising a cathartic - as the gout is usually ushered in by several premonitory signs. Alum is a bad remedy in Dysentery; all astringents are not however bad, I have cases cured by the ext. of Kateshu.

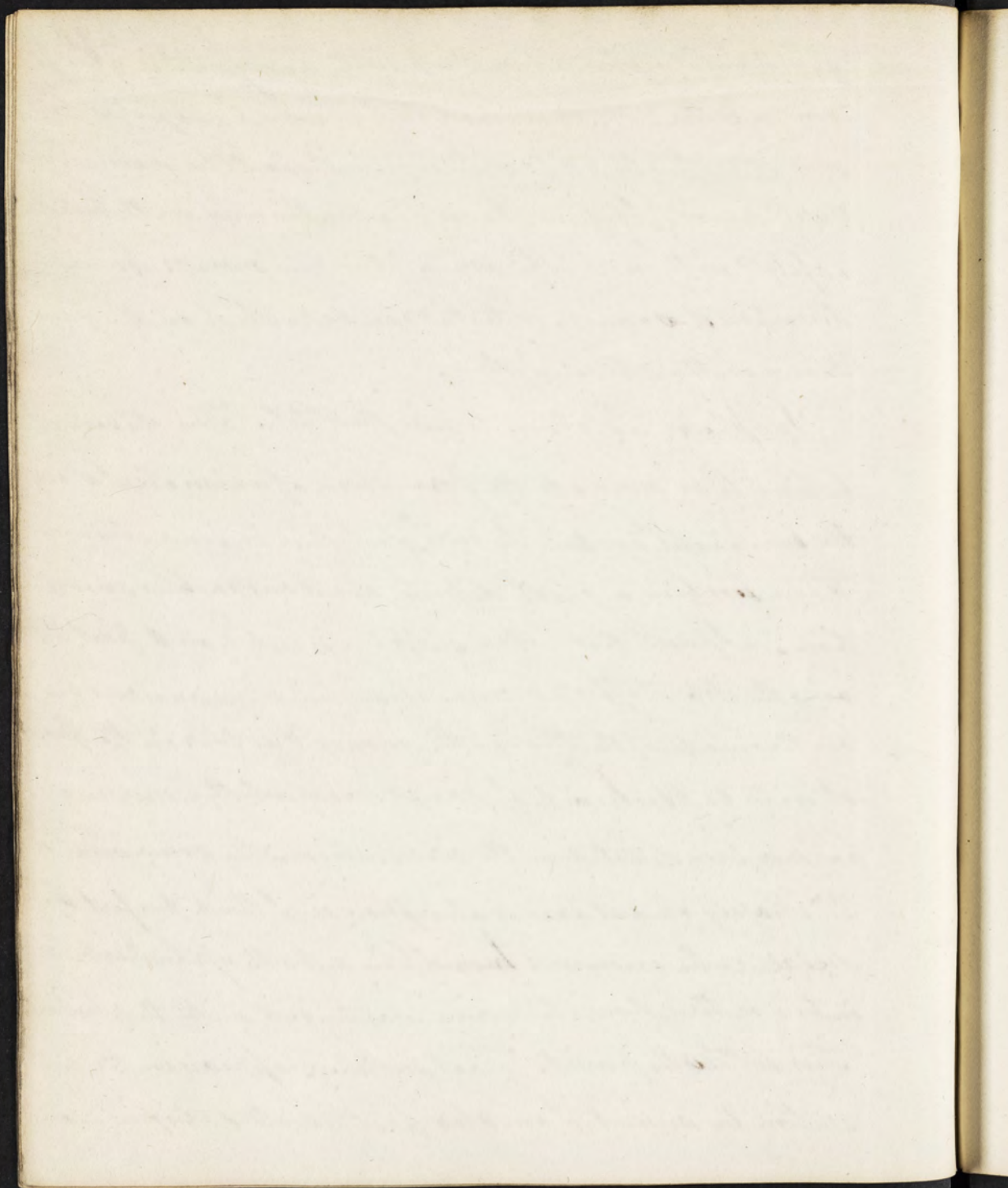
Barytes has been employed to cure Scrophula, I have often made the muriate for Ferriar in these cases - but it was never of any service.

Phosphorus - I have already noticed this as having been



given in Syphilis rubbed up with honey. It is also ²⁹⁰ given in Ether & Alcohol - but the best way I suspect is to mix it with olive oil: with which it should be gradually well ground. I believe it can be given this way with more safety & with more efficacy - as it is then more gradually decomposed - so much so that it can be rubbed on the face & hands without burning them.

Sulphur. Is given to cure the Itch. This disease I believe to be owing to the formation of animalcules in the lymphatic system - to cure ^{it}, Sulphur is generally used. There has been a great dispute about cutaneous absorption. I know that when sulphur is rubbed on a part, having the itch - it effects a cure - also when mercury is rubbed on the inside of the thigh - the money & silver in the pocket will be blackened. I do not know whether mercury has ever been detected in the circulation - the experiment of Dr. Macej on cutaneous absorption is I think perfectly decisive - he immersed himself in a bath of rhubarb - & in two or three hours his urine was tinged with the rhubarb. This settles the point. That sulphur appears in the excretion by sweat - I am also pretty well satisfied - some

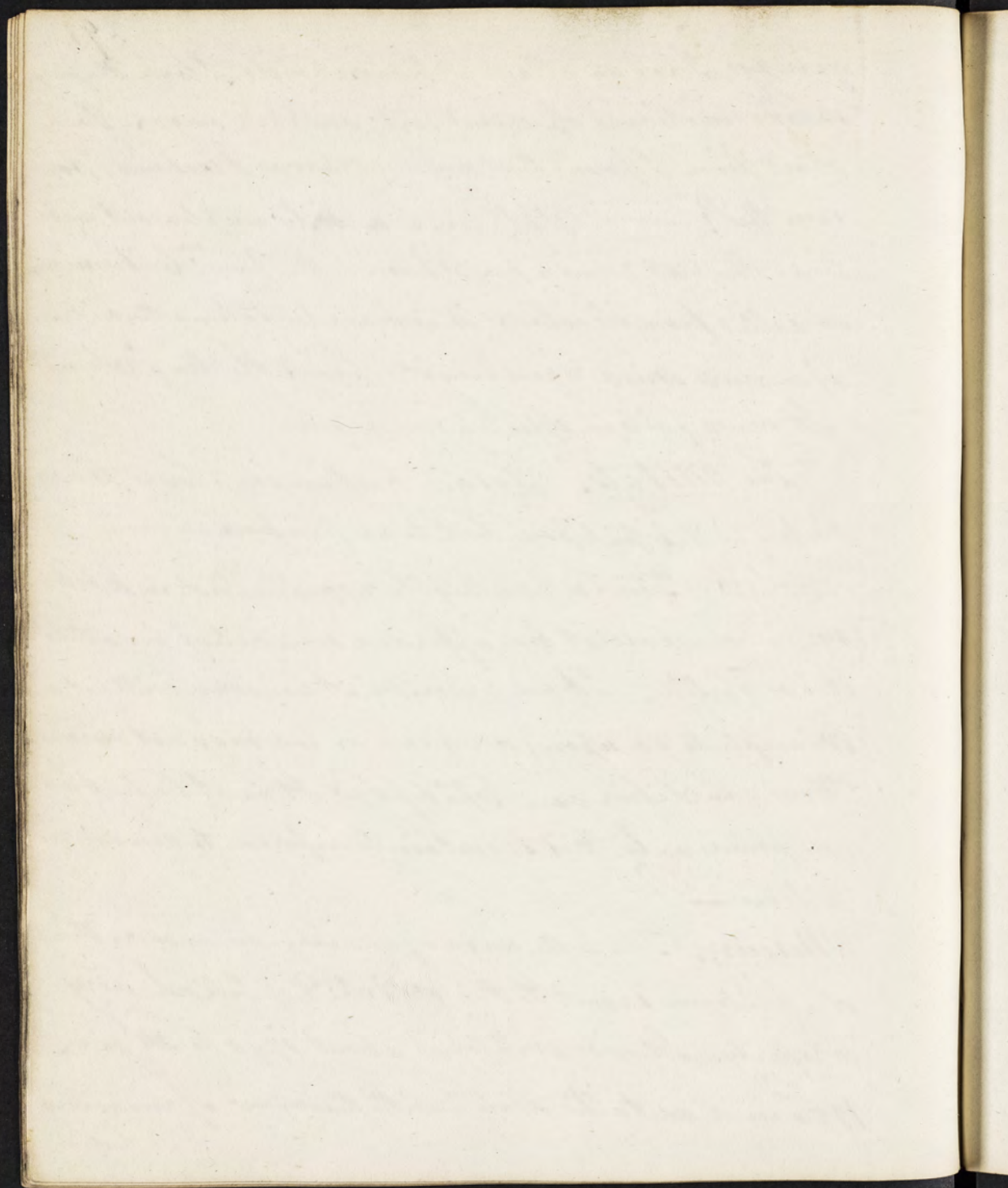


years ago I had an attack of hemorrhoids - I took the purge already mentioned of crem^r tart, sulph: & sugar - In a short time I found that my watch was hastened. How was this? — Sulphur is a dirty unpleasant medicine. The best remedy for P^rasa is the Ung^m: Citrinum, so called from its colour: it is made by taking the nitrate of mercury dried & rubbing it up with the Ung^t: Semis: It never fails in effecting a cure —

The Metals. Gold. Has been employed to cure Syphilis & Epilepsy - but to no purpose —

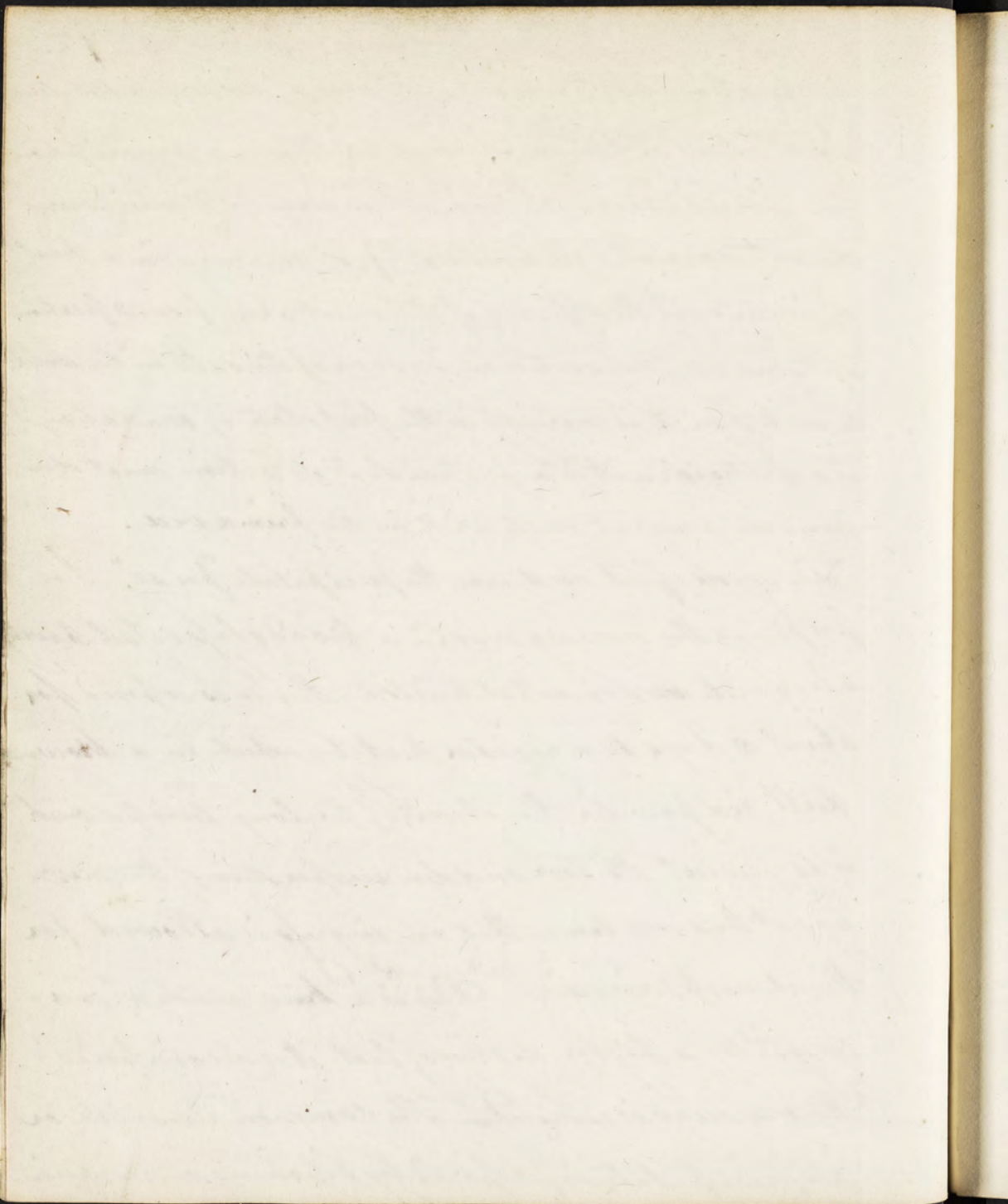
Silver. This has been highly recommended in Epilepsy: in some cases it has afforded some relief in others it has failed. If we prescribe at random without any principle to go upon, we may or we may not succeed. How can Silver cure Epilepsy? It must be by its tonic powers only. & it is certainly inferior to arsenic as a tonic —

Mercury. This is the reign of mercury - when every thing else fails, we resort to this article: & I believe very properly. It was employed about 1740 to the year 1750 in a metallic state - with the view of removing



obstructions by its weight. It was of no service whatever. In Wierley's old book I remember there is a prescription for worms which I took when a child & which cured me - it consisted in boiling 3j. of mercury in a pint of water - all the efficacy of this must arise from a portion of the mercury being acted on by some of the salts in the water. Plenk's pill is mercury in the first state of oxidation, it is a protoxide - it is a protoxide - its action must depend on acids it meets with in the primæ viæ,

The oxide first used was the precipitate "per se." In preparing this mercury was in a broad glass vessel having a long neck ~~at~~ somewhat twisted - this was exposed for about 8 days to a regular heat by which ^{it was converted into} a brown, dull, red powder; the object of the long-twisted neck is to prevent the too sudden evaporation of the mercury - at the same time that an ingress is allowed for the atmospheric air. This is a true oxide of mercury - by a higher degree of heat it is decomposed & the mercury is revived. The common red-oxide or red precipitate is prepared by dissolving mercury in



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Of this acid, evaporating it to dryness & then heating it in an iron ladle till the red fumes have passed over. At first this preparation is of a dull red colour - but it becomes sparkling by exposure to the air - it is no respect superior to the precipitate "per se" - & is after adulterated with red-lead - which could not be done with the other - The precipitate per se is more uniform in its action than the other; in doses of gr. ss. twice a day it uniformly salivates & seldom purges. The red precipitate by Nitric Acid is not exhibited internally at present - but is employed externally as a stimulant or as an escharotic application.

The Sulphate of Mercury is not out of use - ^{the} best is a very harsh & emetic.

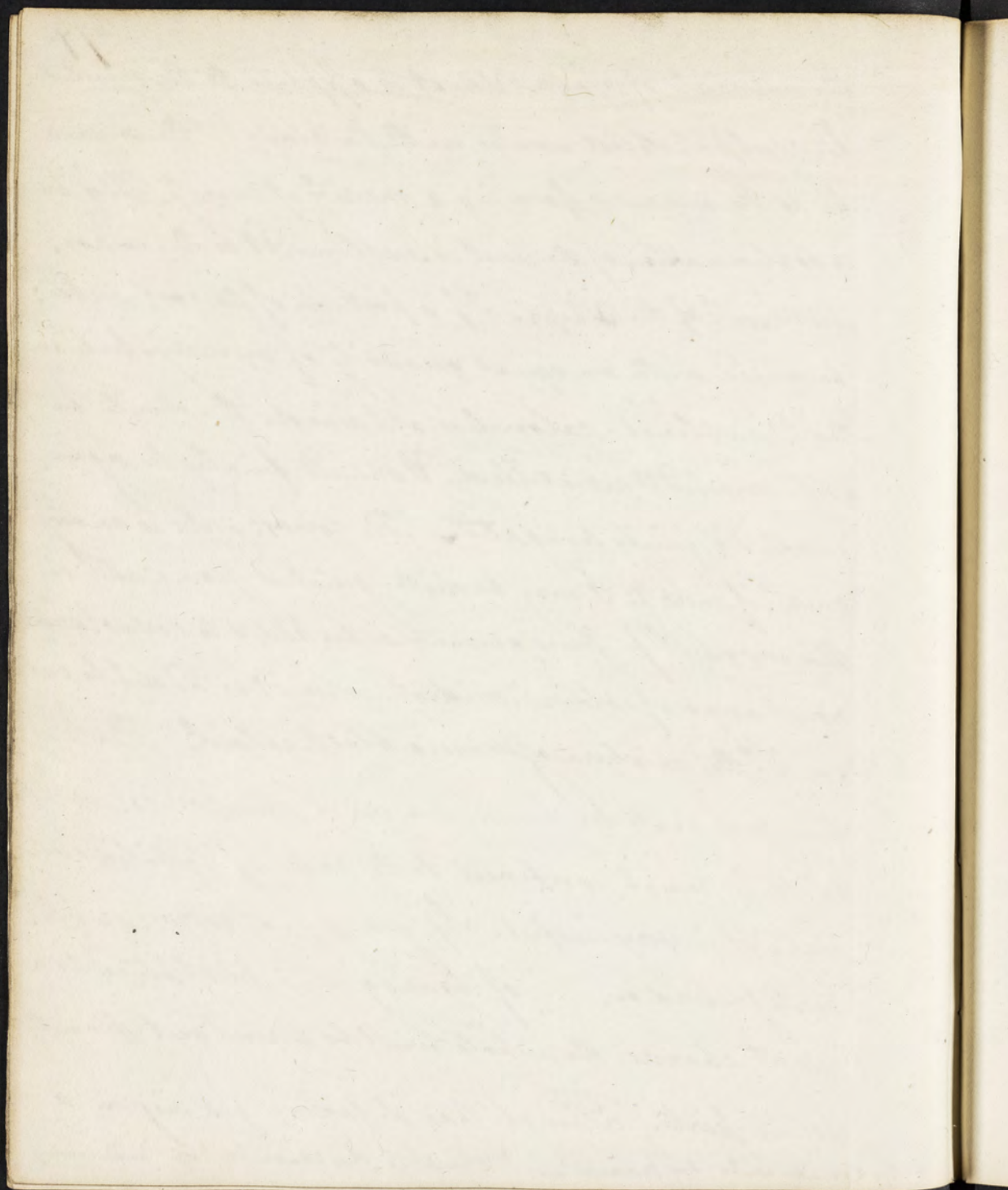
The Muriate of Mercury, This is of two kinds - the sub-muriate - & oxy-muriate - $\frac{M. Hs. to x.}{\text{of oil of vitriol}}$ be added to an equal weight of mercury - & reduced to a dry mass by boiling - a white powder will be obtained which if thrown into boiling water forms the turpeth mineral - When however the white powder is added to

x on the contrary the white precipitate will
be thrown down.

the muriate of Soda & heat is applied to the mixture
 the Sulph^r Acid unites with the Soda & the muriate
 to the mercury, forming a muri^l of merc^y. This by
 a continuation of the heat is sublimed: It is the corros:
 sublim^l of the Shops. If a portion of corros: subli:
 be mixed with an equal quantity of mercury - triturated
 & sublimed - calomel is obtained - this should be
 well washed & ^{re-sublimed} redistilled, & should finally be again
 washed & finely levigated. The corros: sub: is an oxy-
 mur^l of merc^y: & may be distinguished from cal^l in
 this way - If pure ammonia be added to corros: sub:
 no change of colour is evident - when it is added to cal-
 -mel - the mixture assumes a black colour. Both of
 these preparations are much used - the corros: subli-
 -mate is much confined to the uses of stylicin: exter-
 nally it is very useful. If grs. x x. of corros: subli:
 be dissolved in of brandy - and be applied to a
 recent chancre - the whole will be turned out from the

sound parts. Pringle has dissolved grs. viij in a

+ Calomel will be ^{decomposed} ~~precipitated~~ which is the black Ox^l of mercury



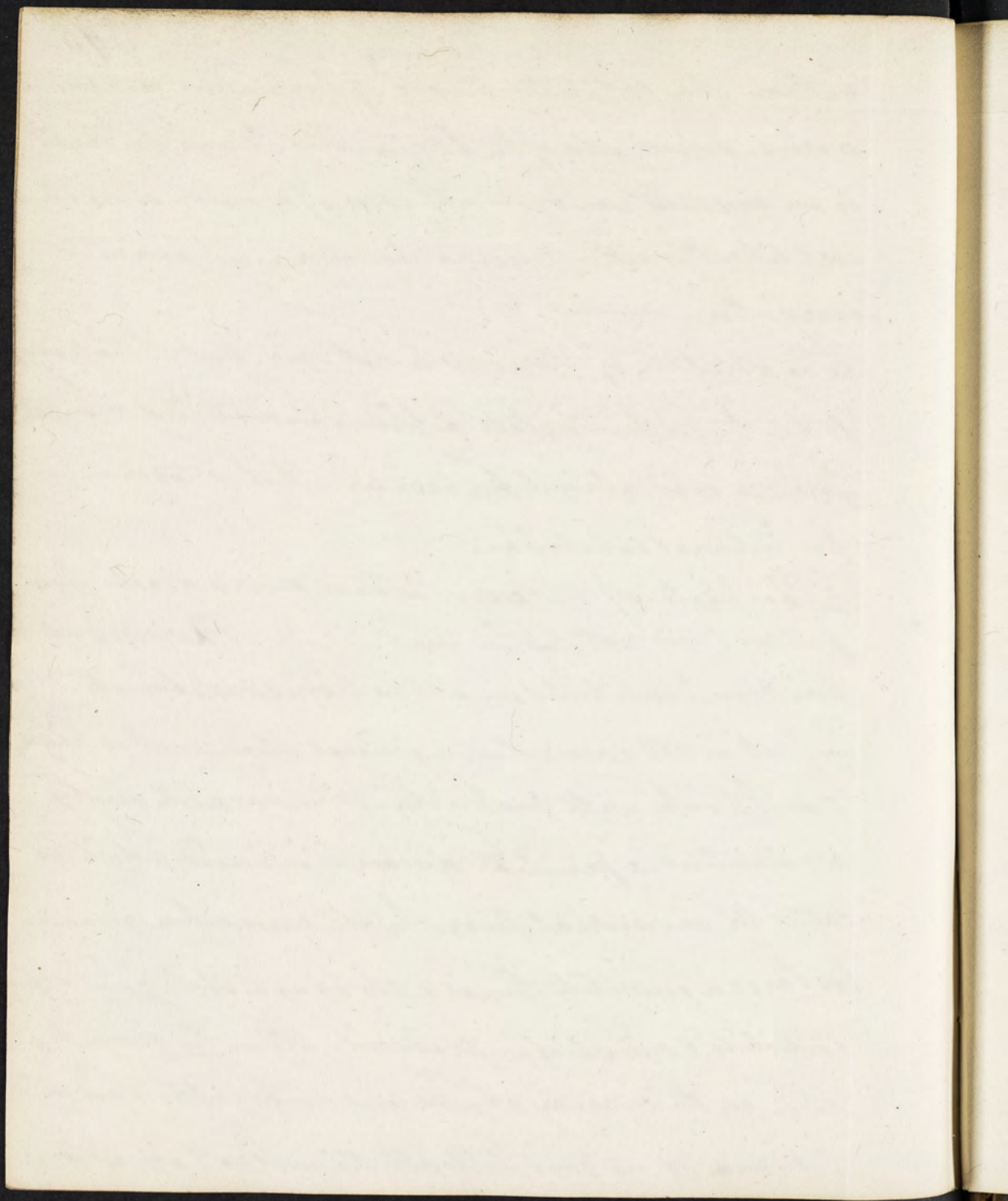
pint of brandy - of which $\mathcal{Z}\text{ij}$ was given as a dose
 so that salivation was induced in four or five days
 It is said - that this practice does not effect an absolute
 cure - but merely moderates the symptoms. Corros:
 Subl^e is an excellent poison for vermin especially
 the common bed bug, grs. $\text{x} + \text{v}$ being dissolved in a
 pt^l of Whiskey - being rubbed over the bedstead not only
 destroying them at the time, but prevents the appearance
 of future visitors - Calomel is the mild sub: mur: of
 mercury - It is sometimes apt to excite nausea & often
 remains on the stomach for a long time inactive. As
 an anthelmintic it should be given in small doses,
 so as not to operate too speedily - but to remain in
 the bowels, that it may poison the worms - a strong
 purge should then be exhibited to bring them a-
 way - Calomel is the best remedy for the botts in
 Horses - Larger doses may be exhibited to these ani-
 mals in proportion to their bulk than to a man
 Speaking of worms - I may observe - that Dr

x Yes it is and: it forms Keyser's pills.

Cutworm has exhibited the oil of turpentine in cases of worms. especially of the tania - This I have no doubt is an excellent remedy in all cases of worms - as no insect likes this oil - Mercury however is superior to every other -

The Acetate of Mercury is not used. but I think ought to be - the red precipitate dissolved in distilled vinegar forms a good external preparation - but is too nauseous for internal exhibition.

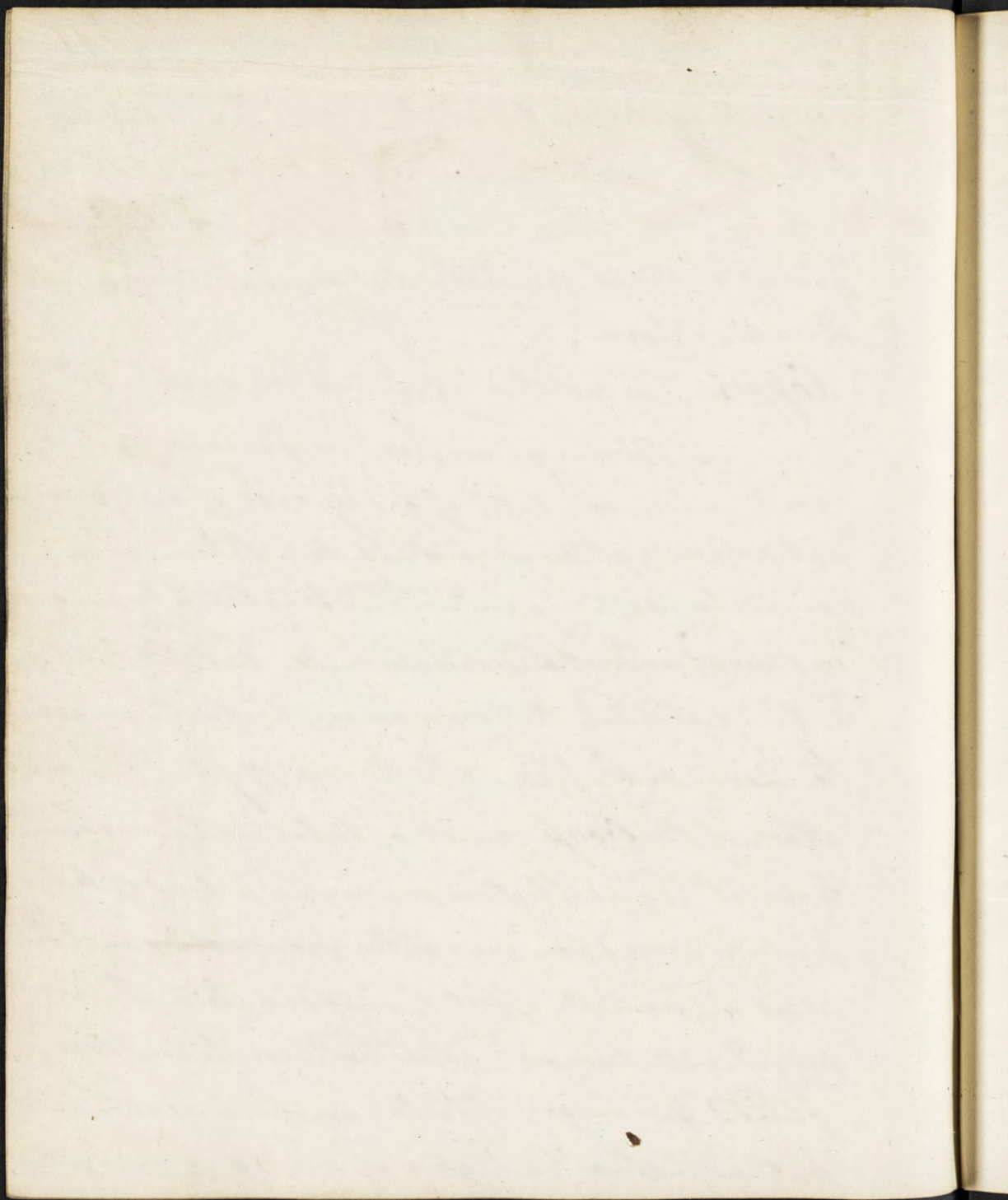
Phosphate of Mercury. This is a very drastic purgative - & is not much used - Mercury is very much exhibited in all bilious complaints - & in part in all cases where a general stimulant is required & as I think with propriety. When incautiously administered. a peculiar disease is induced which is called the mercurial fever. In all cases when given in too large a quantity there is a stoppage of its good effect, & debility & morbidity is produced. When the fever has come on the mercury should be immediately laid aside - it can do no good, till all the inflammatory symptoms



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are removed. In prescribing ^{this medicine} its effects should be carefully watched. The instant there is a metallic taste in the mouth & a soreness of the gums it should be discontinued - if carried beyond this point - it will produce indirect debility - destroying its tonic effects it will do harm.

Copper. This metal is exhibited as an emetic - Mr. of Birmingham has been famous for his dry vomit - which consisted of grs. iij or iv of verdigrise - with which he allowed no drink to be taken - he succeeded by practicing boldly - The English physicians in general understand diseases well - but their practice is timid - When the common emetics fail - we come to Zinc. or Copper - In the year 1798 - I had an attack of the Croup - grs. iv of tartar emetic was given to me, it had no effect in one hour - a kind of Hydrophobia - came upon me - either from ~~really~~ real disease or from the effect of imagination I was seized with tremors & could not bear to touch any fluid - 4 more grs. of tartar emetic was exhibited but ineffectually - 4 grs. of verdigrise were then

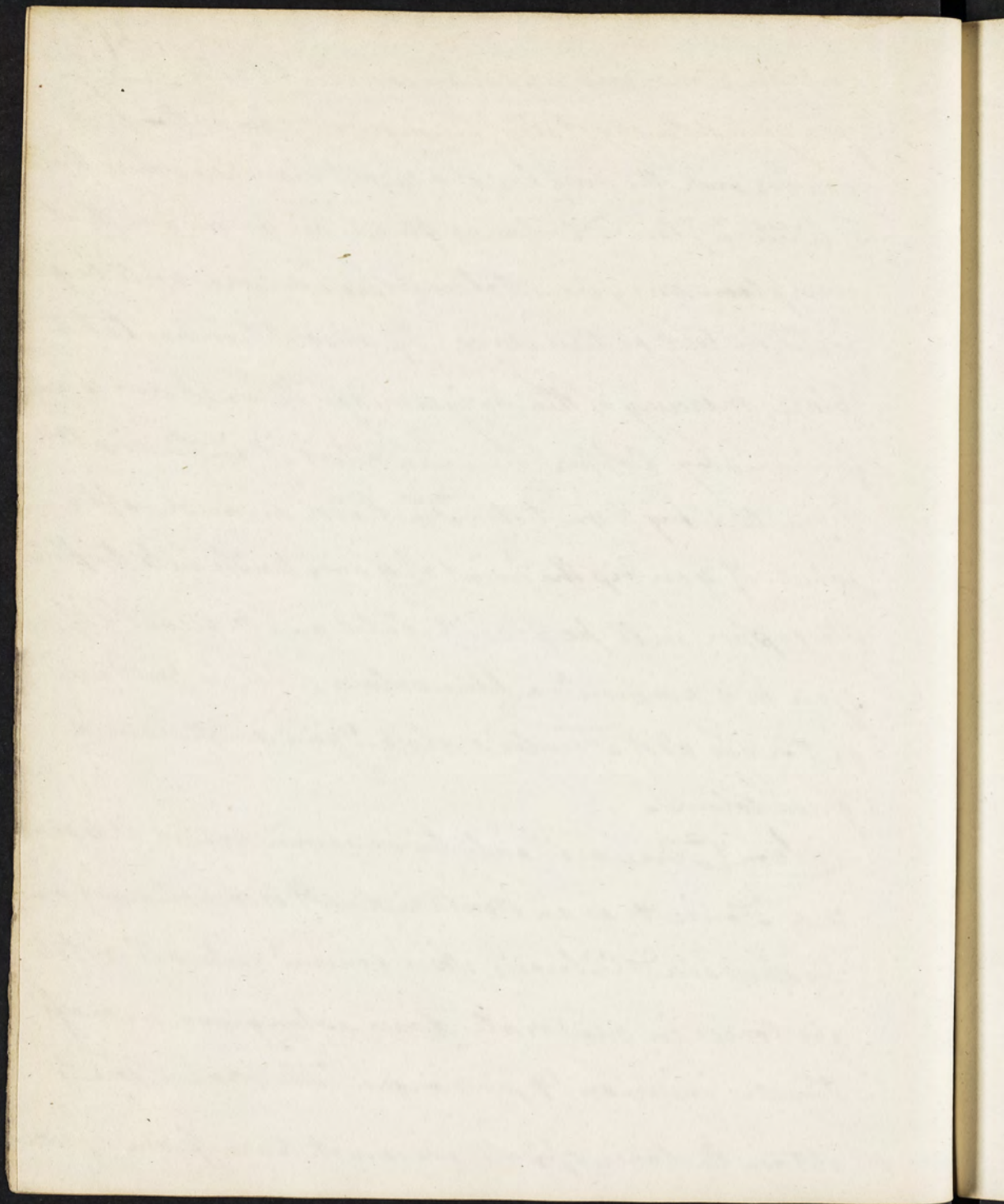


administered - vomiting came on & I was immediately cured. Lettson says that no one recovers from Croup without bleeding. I have never known one cured by bleeding. Many years ago while in Eng^d my Son had an attack of croup - Dr Ferriar attended him. Emetics of every kind were given to him - but with no effect - the disease rapidly progressed & became very violent. The Dr. came to me & informed me that my child could not live, more than one hour. I then resolved upon the following experiment. I took some hot water ~~in~~ on the surface of which I poured some ether. The fumes arising from this I made him breathe by closing his nostrils & directing the vapour towards the mouth - This induced suffocation - the abdominal muscles were thrown into action - & the emetics formerly taken, now operated freely. He recovered. This is a fact - worthy of your remembrance. In all cases, if your product ^{full} vomiting - your patient is safe - at least I have never seen or heard of a case to the contrary. Kopper - in the form of

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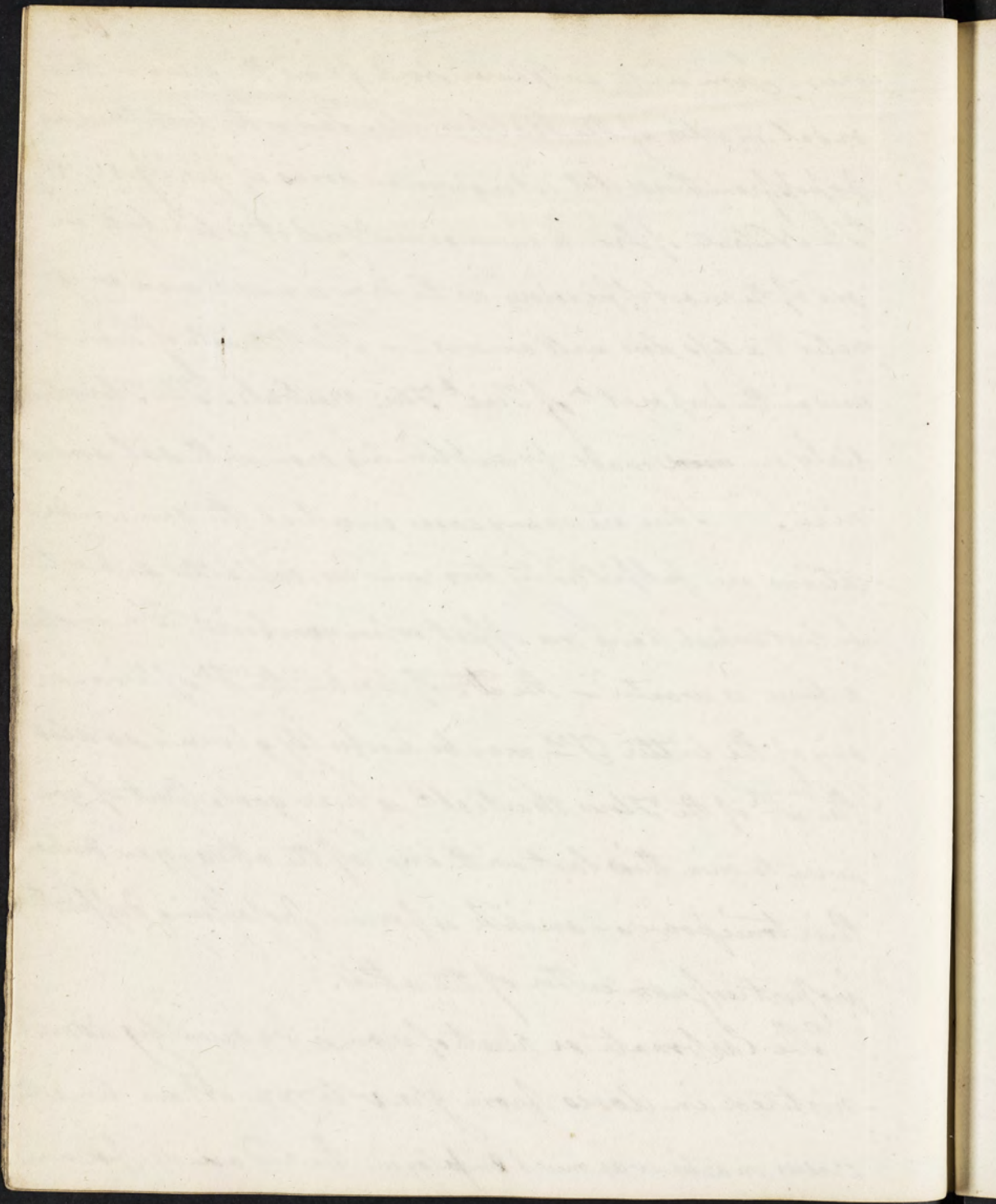
Cuprum Ammoniacum is an excellent tonic. If you grind the crystals of verdigrise & spread ~~the~~ fine powder over the surface of a recent chancre where there is little inflamⁿ & where no fluids are formed so that absorption may have taken place a cure will be effected in two or three days. If absorption has taken place, mercury is the only remedy. When persons are poisoned by Copper you can detect it in the matter vomited by 3 methods - First add an acid - after which if you dip the point of your knife into the fluid the copper will be precipitated on it. secondly if you add ammon^a a blue colour will be produced - or thirdly add Fowler's drop you will have a green colour.

Iron - There are only two cases in which it is given as a Tonic & as an Antacid - It is much used in Dyspepsia & Chlorosis. As a general rule all metals are tonics in moderate doses - when given in excess they are injurious & poisonous. The proper dose to obtain the tonic effects - we must learn from experie-



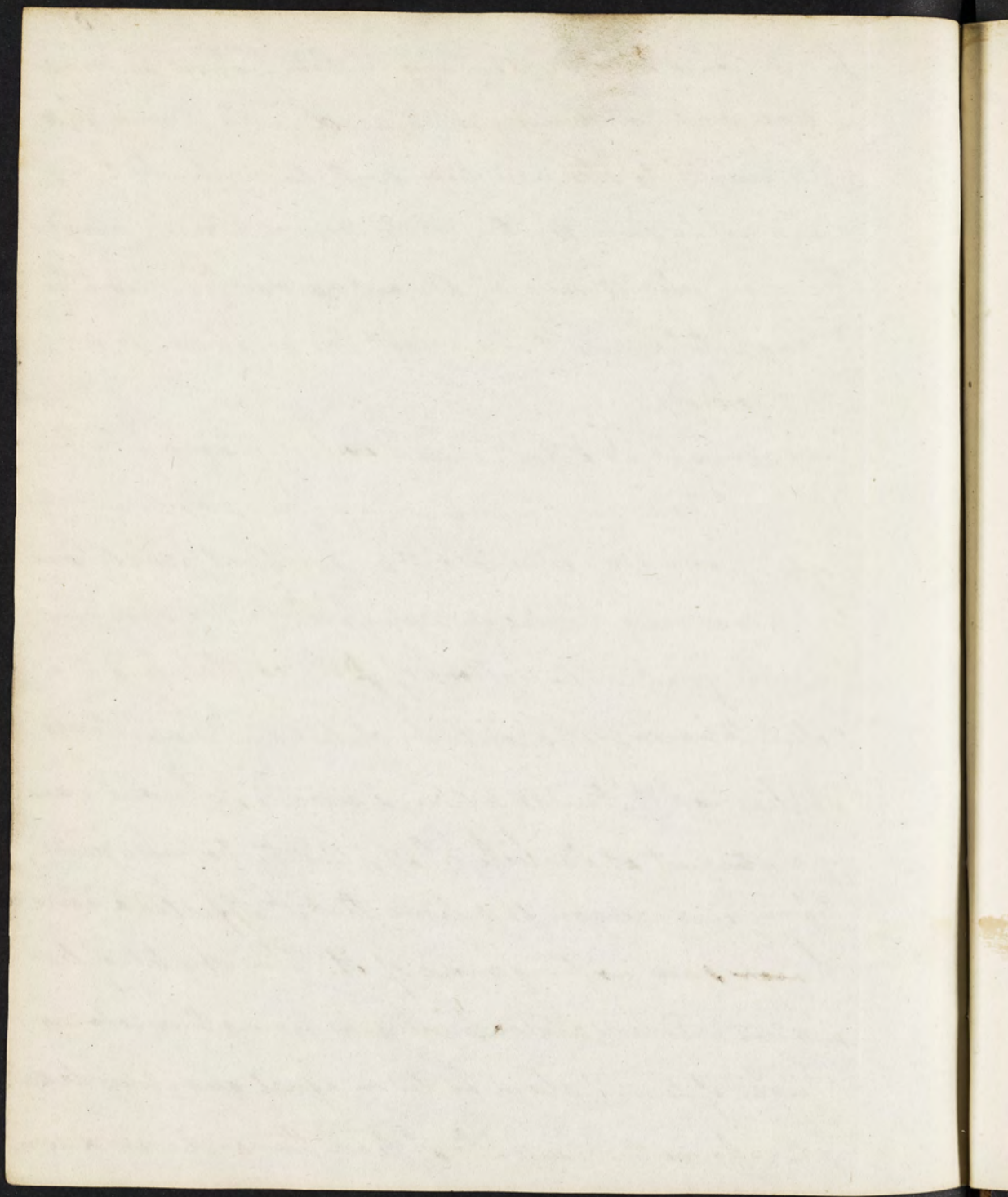
-ence. Iron with sulphuric acid forms the green vitriol or sal martis of the old Chemists. This is the best tonic we possess from this metal - it is given in doses of grs. iij, iv, v. The Nitrate of Iron is never given & yet it is likely to be one of the most efficacious - as the iron is much more oxygenated & a little dose will answer. The Muriate of iron is used in the preparation of Tonic Flor. Martialis. The Flores Martialis are ~~used~~ made by subliming iron with sal ammonia. There are many cases in which the same indications are fulfilled by two remedies exhibited separately but which have no effect when combined. For instance a tonic is wanted - the Gr^{os} of bark - the Gr^{os} of Kino - or any of the bitter Gr^{os} may be usefully given - so also the Gr^{os} of the Flores Martialis is very good. But if you were to mix this last with any of the others - you destroy their tonic powers - an ink is formed possessing different properties from either of the others.

The Carbonate or rust of iron is frequently administered in doses from grs. v to xx. At one time the crocus martis was much employed - the red oxide forms



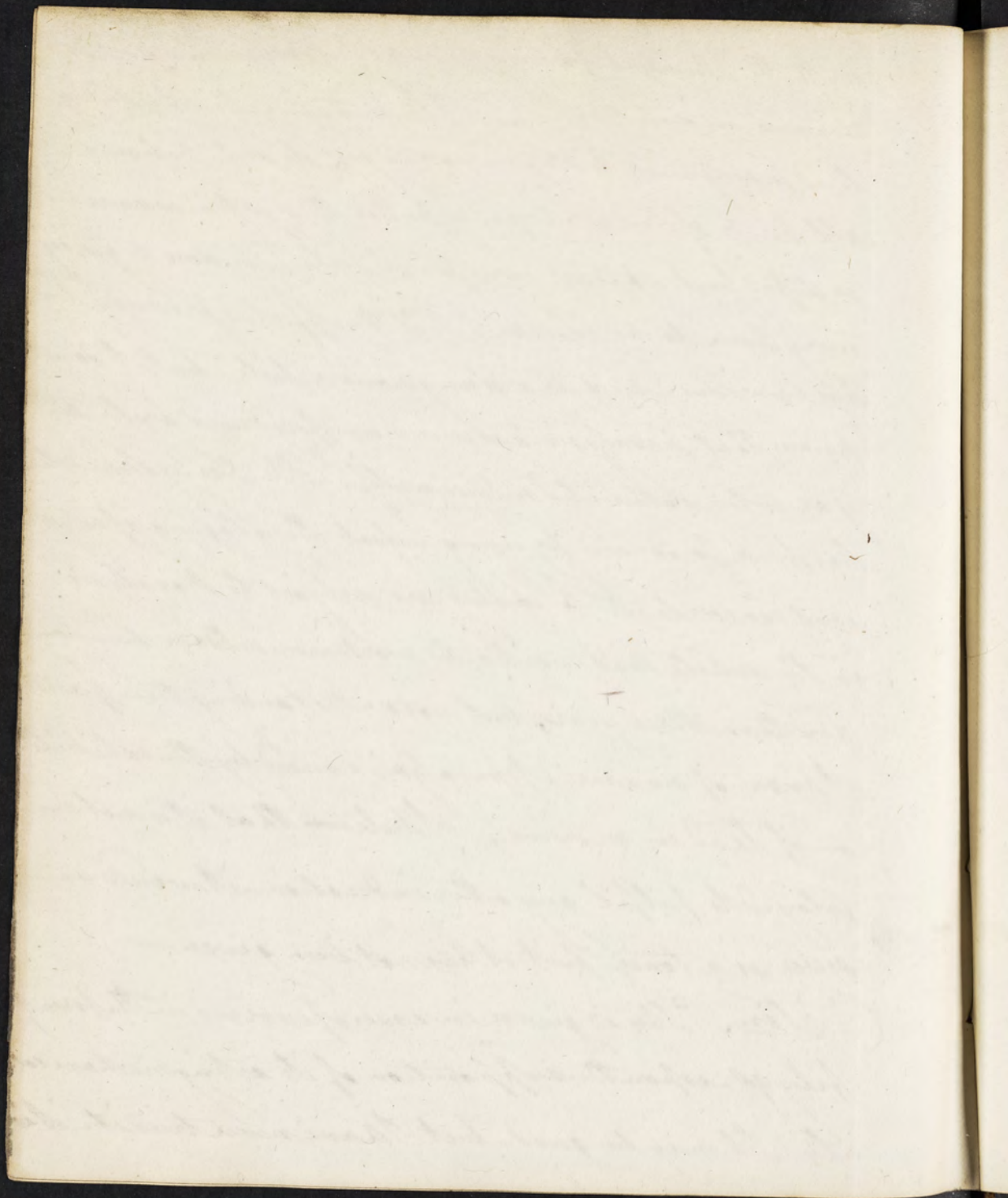
ly mentioned is better than any of them. These are rendered active from combining with acid in the *prima via* it is useful to alternate them with the bark - but they should not be given together for the reason already assigned. The iron filings are very advantageous in chlorotic & dyspeptic cases & I suspect are superior to any of the oxides.

Lead - The acetate is used only in Psoa & Tetters &c. - I have been informed by a friend of mine who is one of our first Chemists & an excellent practitioner that he has never failed in curing Tetters by applying the juice found at the bottom of pots, containing the rolled tobacco - it should be diluted previous to its application & it will always succeed. In one case of a student at Carlisle I applied the tobacco juice, & have every reason to believe, that it effected a cure. I had saw nothing more of it. The acetate of lead is much used by Calico printers in fixing their colours Sugar of lead. & alum added in equal quantities to each other forms the Sulph^e of lead - the acetic acid uniting



with the alumina forming the acet-^e of alumina, which remains in solution. In medicine the object of lead is only used to stop hemorrhages; its ^{influence} exhibition in all kinds of hemorrhage whether the system is excited or depressed appears very powerful. The dose is gr. iij every hour - to be increased, till the effect is produced. This has been considered as a dangerous article - but I do not know that paralysis has ever been produced by the sugar when exhibited medicinally. The Derbyshire colic has been produced by using rums, the gazing of which contained lead. Painters are subject to Paralysis - in the white lead works. The workmen seldom live longer than three years; but notwithstanding these facts I know of no case of Paralysis caused by the exhibition of lead in medicine. I believe that it is not employed to fulfil any other indication - it would answer as a tonic - but it has not been given -

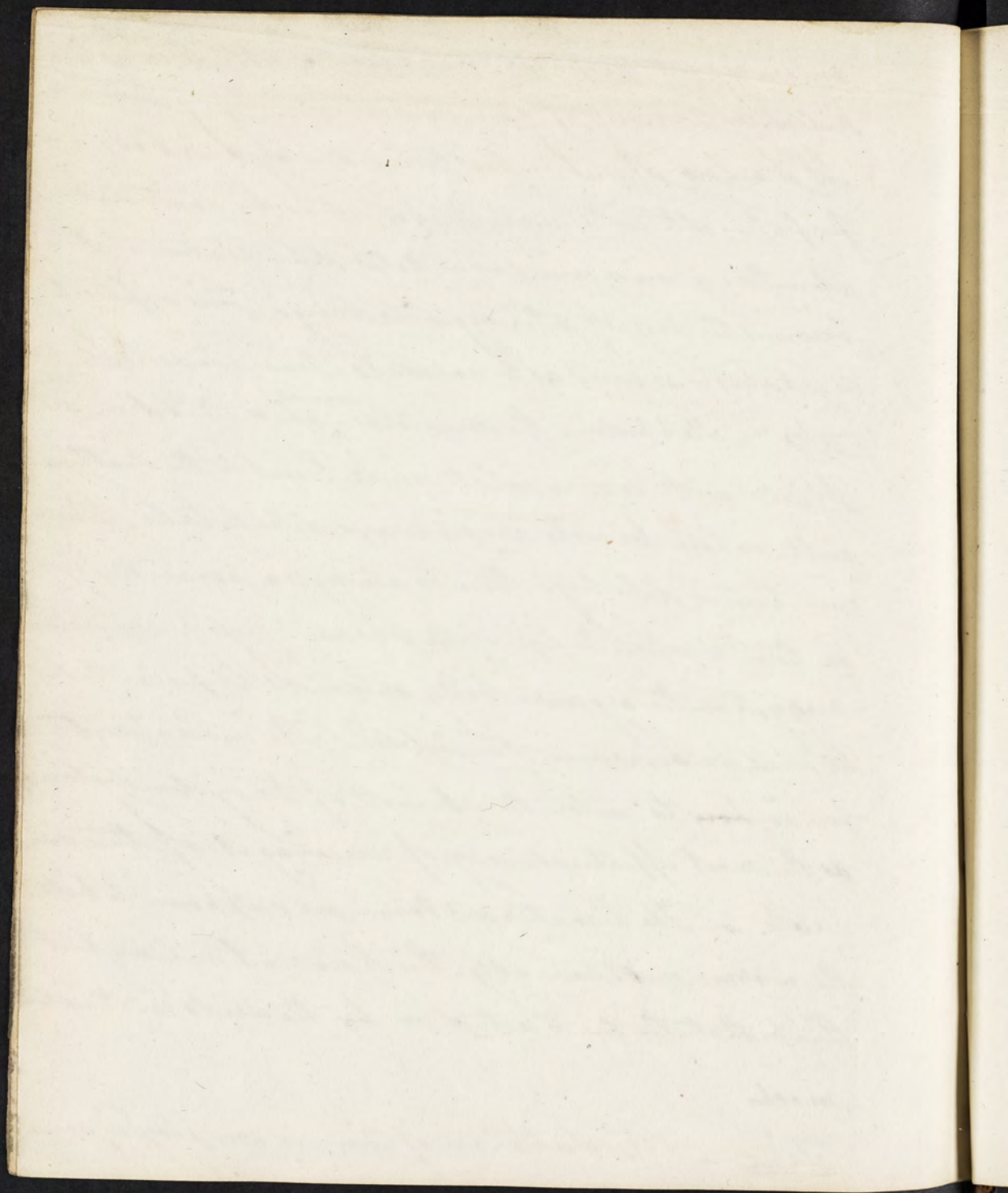
Tin. This is given in cases of worms in the form of filings - upon the supposition of its acting mechanically. It may be good - but I have never tried it - it is



an elegant preparation at least. All worms are killed by Mercury if you make them hungry.

It is a law of nature, that where one organic body is in perfect health - it is never preyed upon by another: but where there is an organic body that is debilitated it then becomes the prey of other organic beings. This applies to vegetables as well as to animals. Hence we see old oaks & Supporting the mistletoe - ^{hence} also children are afflicted with worms which never trouble the healthy adult - whose bowels are no ways debilitated. Where ever there is debility - there is always a parasite feeding on them & where the life of the parasite proper more energy than the organic body on which it feeds - the latter will be overcome & annihilated. The indication, therefore is how to restore the strength of the system by tonics, as the most effectual way of relieving it - of these animals. - The Limatura Stanni are supposed to kill the worms mechanically - this I do not believe, but think that the tin is acted on by the acids in the stomach.

Zinc - The Sulphate of Zinc is employed, as an

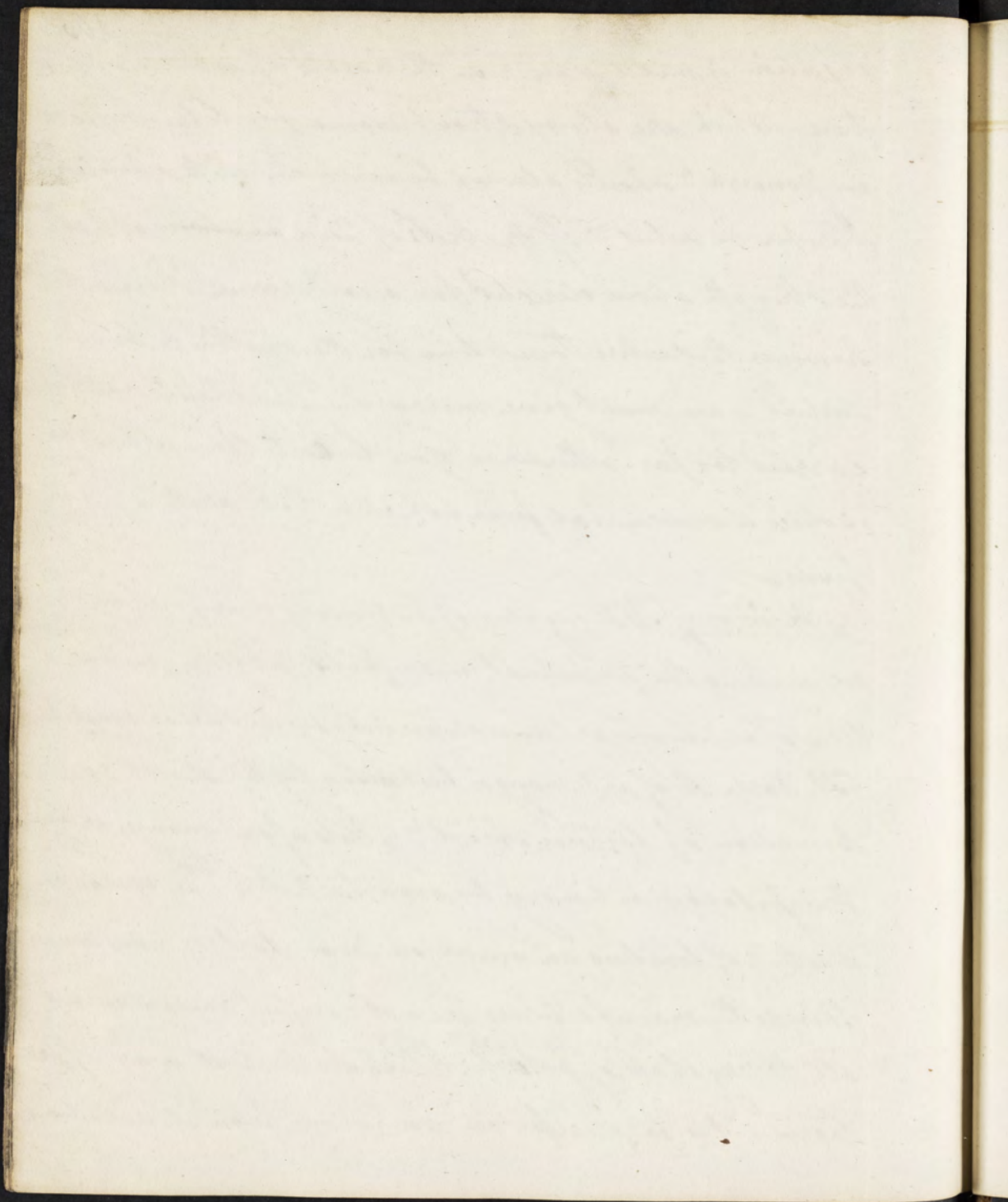


emetic - it is not equal to Copper in this respect as it is
 not so certain in its operation. No danger is incurred
 by using copper in this way, as the whole is fully evacu-
 -ated. Formerly persons were poisoned by using copper
 vessels in their culinary processes - it is a singular fact
 that the vegetable acids while boiling never act on
 copper - unless at the very surface where it is exposed to the
 air. Lime then is of no great value as ~~an~~ emetic - but it is
 very useful ~~as an eye water~~ in certain diseases of the
 eye. When the sulphate is employed - it is likely to do
 harm. the sulphuric acid has a bad effect on the eye -
 this I have seen frequently. The best collyrium is pre-
 pared by mixing equal quantities of Sulph^r of zinc
 & sugar of lead together - an acet^e of zinc is then
 formed which remains in solution. It is the mildest col-
 -lyrium I know of - When diluted with rose water
 so as to be slightly astringent to the taste, it is very
 useful & excellent. Lime is also used as an injection
 in Gonorrhoea. This - I believe, at first to be a local
 disease not ^{the case} however after 2 or 3 days. Unless the

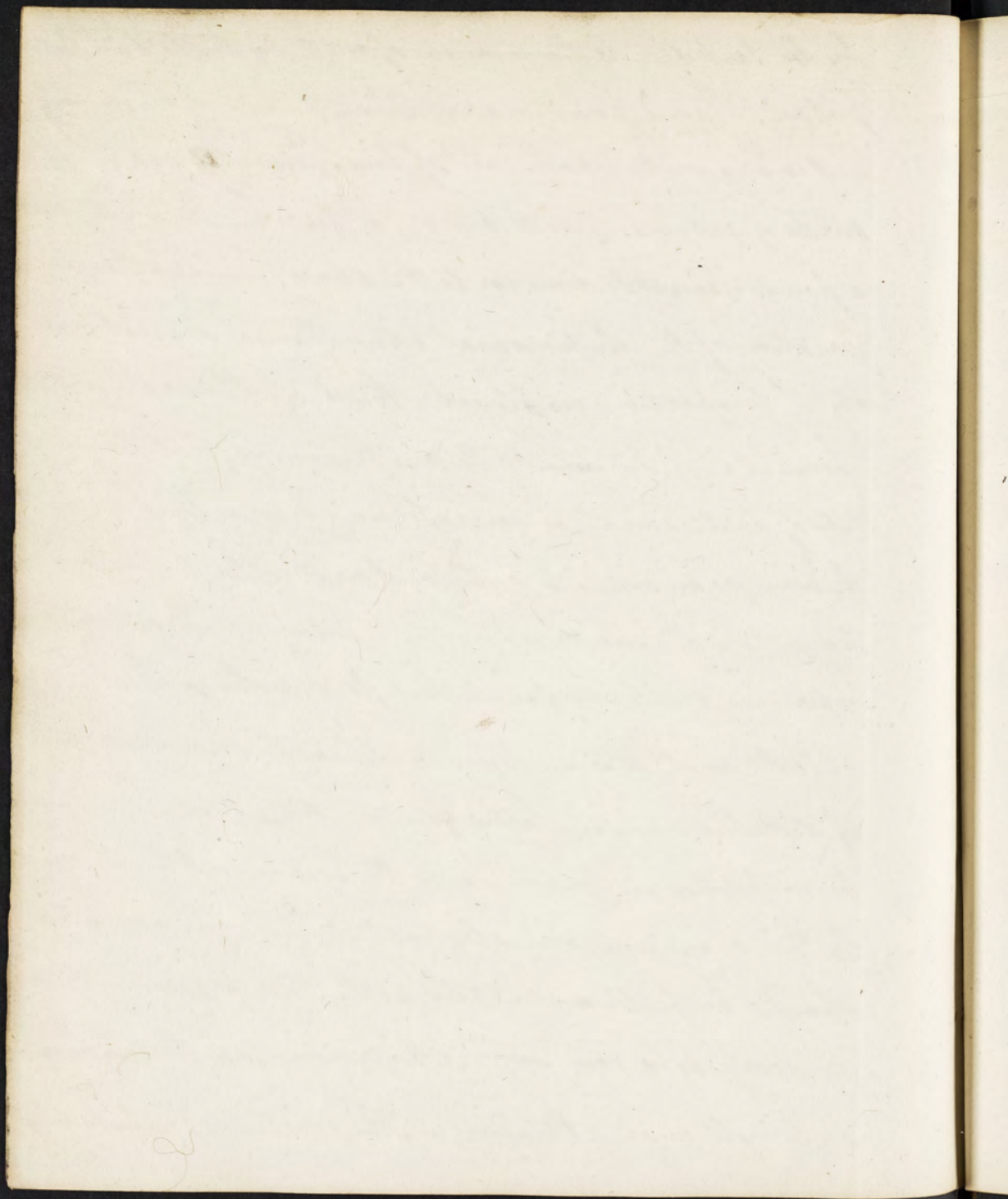
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injection is mild you run the hazard of inducing stricture - which are always troublesome for life. Injectⁿ in Gonorrh^{ea} should always be combined with opiate, I prefer the solutⁿ of the Rect^{um} of Zinc ~~as above~~ of half the strength above directed for a collyrium. Remember however that where there is time for the matter to be absorbed you must give mercury - This should not be carried too far - otherwise you lose its tonic effects & induce a mercurial fever which is the worst of all fevers -

Antimony. The regulus of antimony was first used, as in making the perpetual emetic pills. All the preparations of antimony are now superseded by the tartar emetic. The tartaric acid of antimony is best made by the direct combination of tartaric acid & glass of antimony, or by precipitating antimony by some tartaric acid. The common method of boiling an oxide on Crem. tart^r is very uncertain, as the manufacturers are not careful in removing all the crystals ^{superfluous tartaric} of potash. Perhaps the best way of preparing it is to precipitate antimony from its solution



by ^athe tartaric - as the muriate of ant^y by the tartaric ³⁰⁶ of
potash. Jamel powder was a compound of oxide of
antimony with phosphate of lime. Twenty grains of an
oxide of antimony with one gr. of tart: emetic will form
a powder exactly similar to the above. — In the pre-
paration of the Antimonial wine there is a great vari-
ety of proportions employed. Each apothecary has a
formula of his own. & the misfortune is, that the quan-
tity of tart: emet^c is generally too small. In prescribing
the wine, as an emetic to a child. it will often be in tonic
-ted before the emetic operatⁿ is induced. From my own
experiments I have found that to dissolve perfectly gr^s.
of tart: emet: it is necessary to employ two tea-spoonfuls
of distilled vinegar. This fluid I think should always
be employed in preference to the wine as it keeps equal-
ly. & is of one uniform strength. The vinegar also
should be fully saturated as then a less quantity is
- necessary to be done — Antimony was formerly much
employed as an alterative. The practice of exhibiting



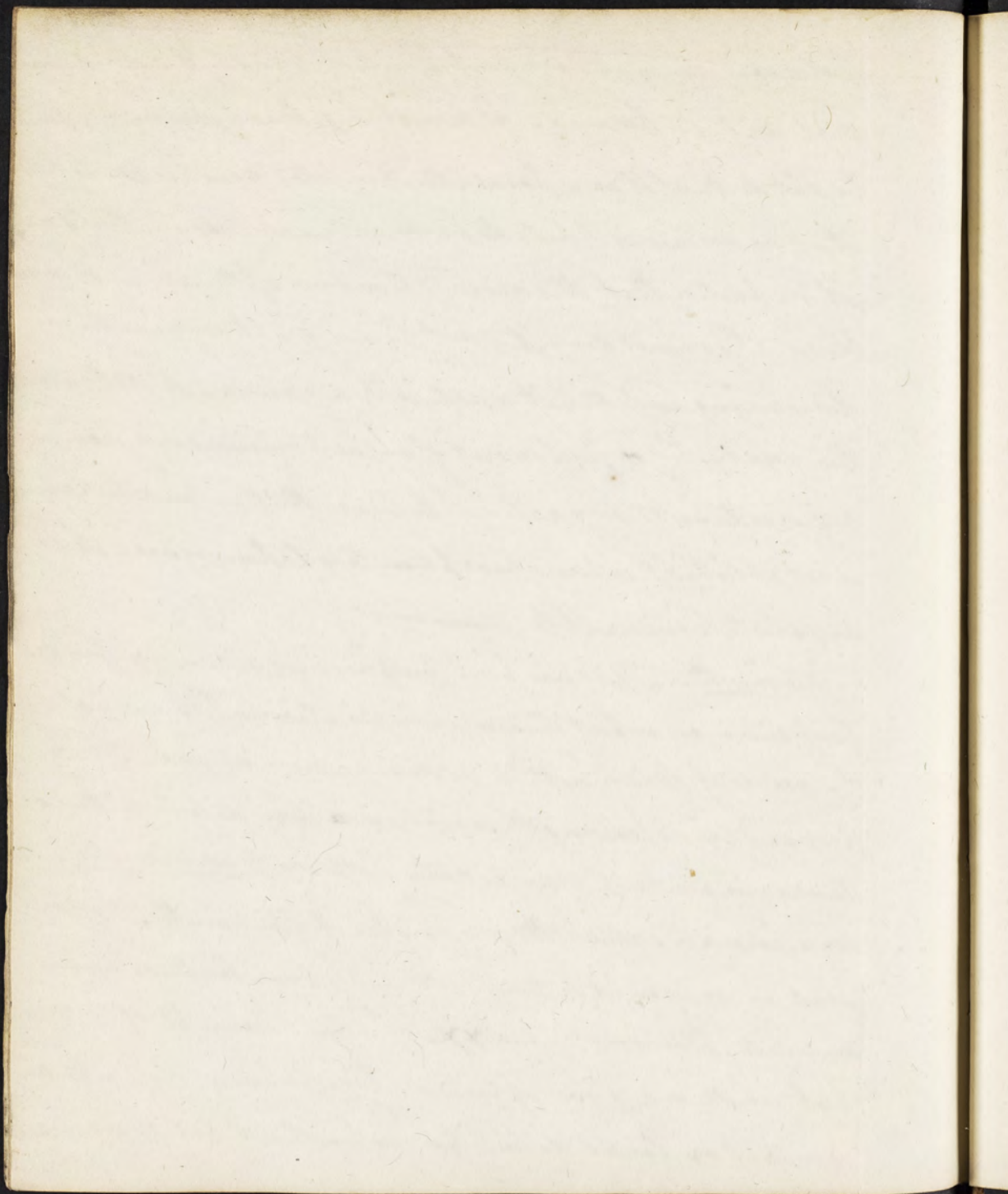
medicines as alteratives - that is - to give them in small doses with ~~an~~ view of gradually changing the condition of the system - is in a great measure neglected at present - & I am sorry for it - as it is certainly very useful. —

Arsenic. I have often mentioned that all metals are tonics in proper doses. The metallics are superior to the vegetable tonics - but it is often necessary to alternate their use - but they should never be compounded. Of all tonics, none is so good as Arsenic. It is also an excellent test of the presence of copper - if to a liquor containing copper, a drop of sulphuric acid be added & then a few drops of Fowler's solution - a green tinge will be evident - affording a most delicate test. Some prescribe it - in the form of arsenious acid - this is wrong in as much as it has a nauseous metallic taste. The arseniate of potash, as directed by Dr Fowler is the best preparation - Arsenic has been said to cure cancer. I do not know whether cancer has ever been cured, it is like curing a confirmed case of Phthisis Pulmonalis - a thing never done - Some person has compared cancer to a parasite animal - to a

x The dose is not so large as this.

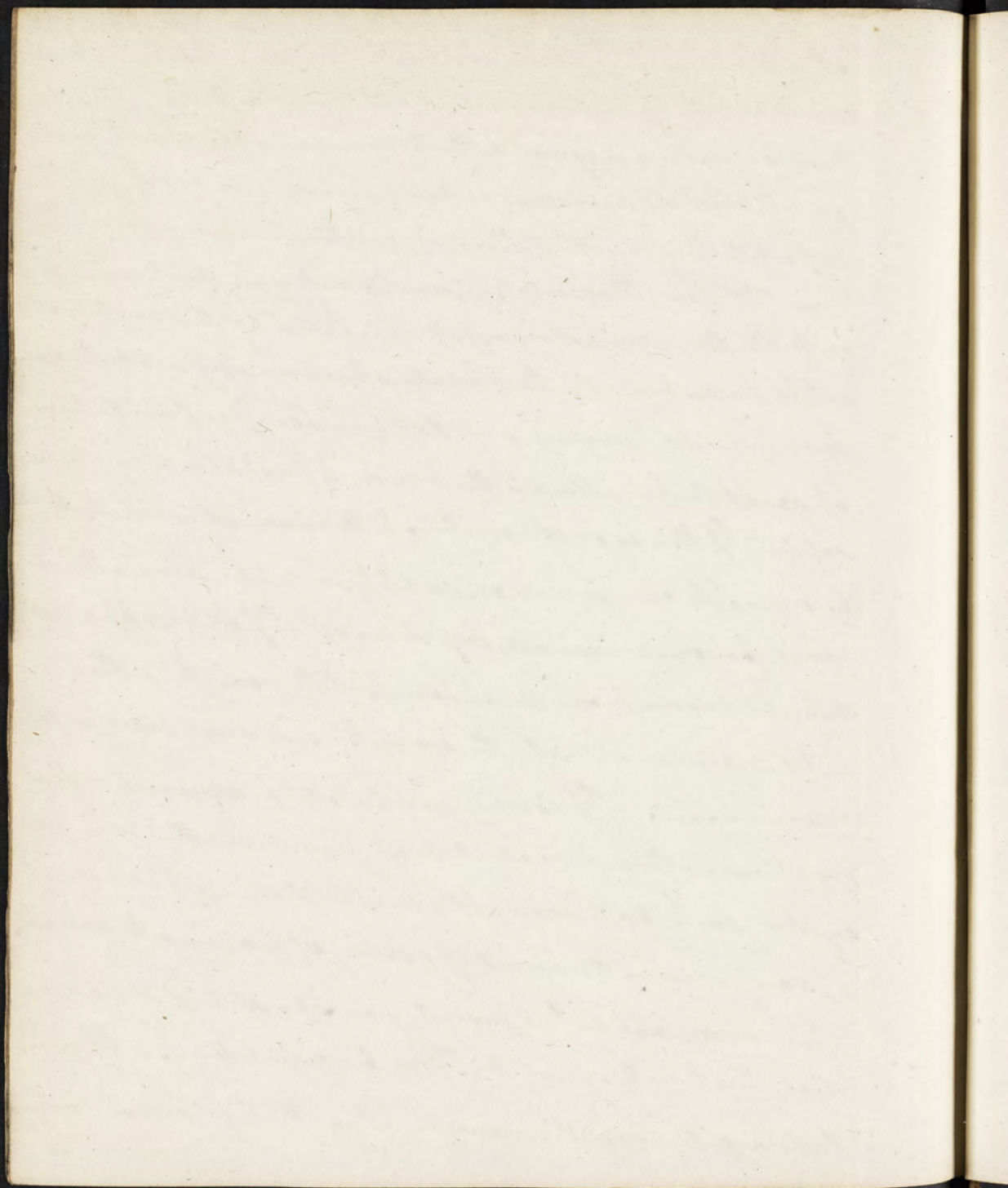
Polypous animal - any part of which being left a new animal will be formed. Where it is a local disease I should be apt to treat it as a parasite. I employ caustics ~~to~~ to kill it - here arsenic is likely to be as serviceable as anything else. It is reported, that this disease has been often cured - it may be so. I cannot deny it - but there is great difficulty in discovering whether it is actually a cancer - to determine this point - the judgment of an experienced surgeon is requisite. At any rate - I believe, that when ulceration is established & where absorption has taken place - it is absolutely incurable.

Bismuth - This has been proposed as a remedy for Dyspepsia - on what theory or indication know not but the oxide of Bismuth is very much in vogue. It is prepared by dissolving the metal in a very dilute Nitric or Muricatic acid - & precipitating it - by pure water. It was formerly called the ^{oxy}magister of Bismuth. & represents an oxide - it is however a sub-nitrate or sub-arsiate. The dose is grs. $\frac{xx}{x}$. I have known it often given but with no good effects - Dyspepsia depends on general or local debility - when the debility is general



it is to be remedied by air, exercise &c. - When local you must correct acidity by medicines which will gently purge, for which purpose, nothing is equal to the Magnesia - after which astringents & tonics are necessary - as Kino, Columbo &c. &c. with respect to Bismuth I think it inert.

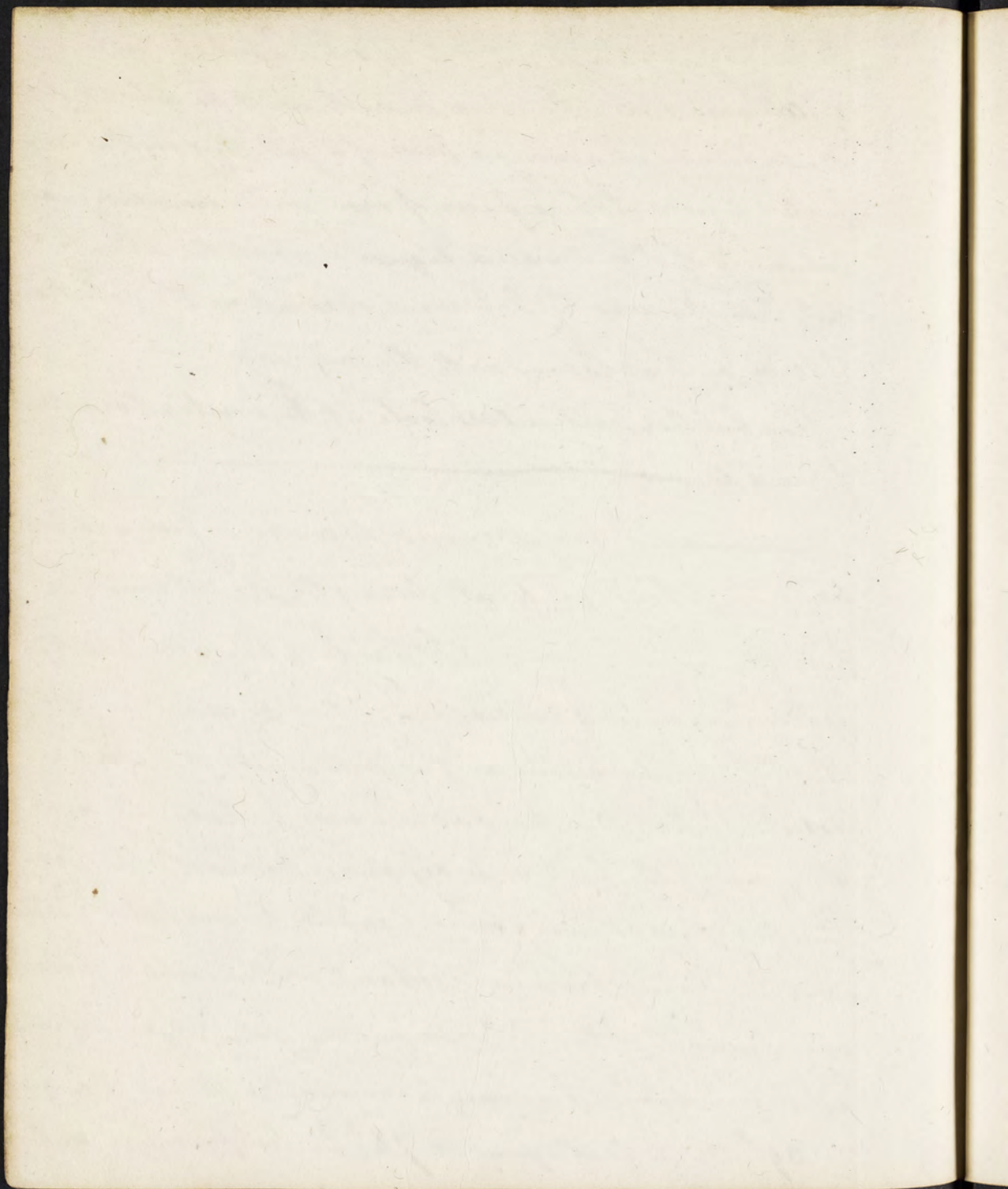
— When Poisons are swallowed - you first enquire into all the circumstances of its exhibition - & the symptoms which succeeded. If the vomiting has been very violent - you may possibly conclude a metallic poison has been taken - If great torpor attends the poison is probably from the acid - If there is great vomiting & tormina - it is likely to be owing to arsenic, *corros: subli^e*, or copper - as an other mineral poison can usually be procured. If it is copper - it may be known from the suddenness of the vomiting - there is little nausea - or heat - the vomiting in such cases is to be encouraged. If *corros: sublimat* or arsenic has been swallowed - there is violent heat produced - then you give emetics - insipidate some of the matter thrown up & burn it - if you perceive the smell of garlic, it is owing to arsenic. If *corros: subli^e* is present - you can detect it by a method first noticed in Dr Pries, *Encyclopaedia*. - If you take a gold ring - & immerse it in the liquor containing



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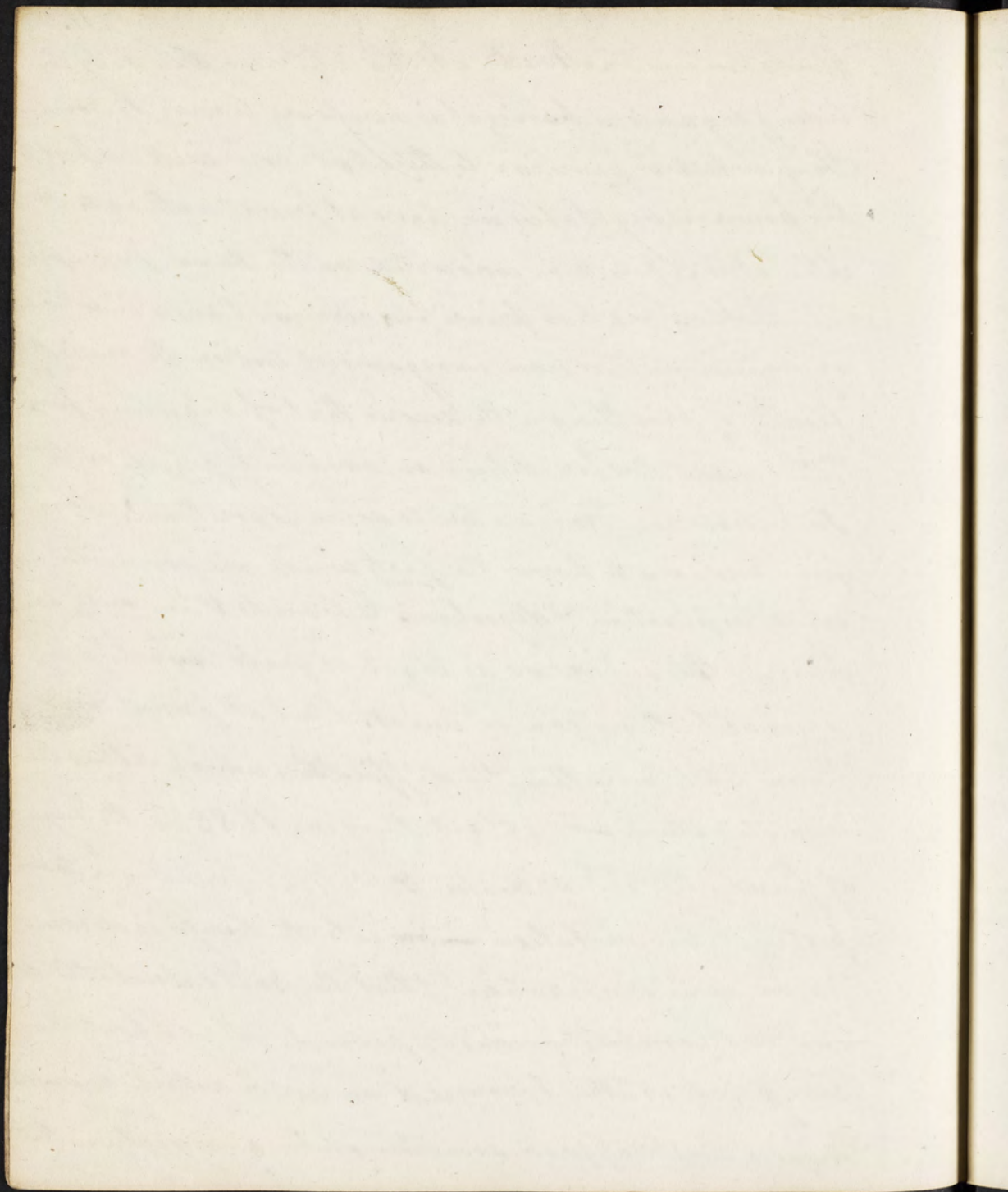
The mercury, no change will be effected - but if you excite
a galvanic action, the corros. muriate will be detected but
this be done by immersing a piece of a gold ring in the sus-
pected liquor - take a piece of iron wire - ~~and~~ plunge one
extremity of it in an acid liquor & apply the other to the
Gold - in this way the Gold will decompose the solution
& form an amalgam with the mercury -
For further particulars look at the works above re-
ferred to

I have promised to make a few observa-
tions on Animal Heat - during the present course of
Lectures - It has long been observed, that
dead unorganised bodies change their temperature with
that of the atmosphere or bodies to which they were ex-
posed - so that their temperature was perpetually alter-
ing - but the fact as to organised bodies differs from
those relating to unorganised matter. To what our tem-
perature living bodies are exposed within certain points
it is found, that they preserve one uniform degree of heat:
in warm blooded animals, even where the cold is equal
to 39° or the heat equal to 95° the temperature of their



fluids remain unaltered. As this is the case, then, only in living organised bodies it is necessary to recur to something which is peculiar to these bodies — with respect to this power in vegetables we have at present nothing to do, altho' it is likely to be conducted on the same principles.

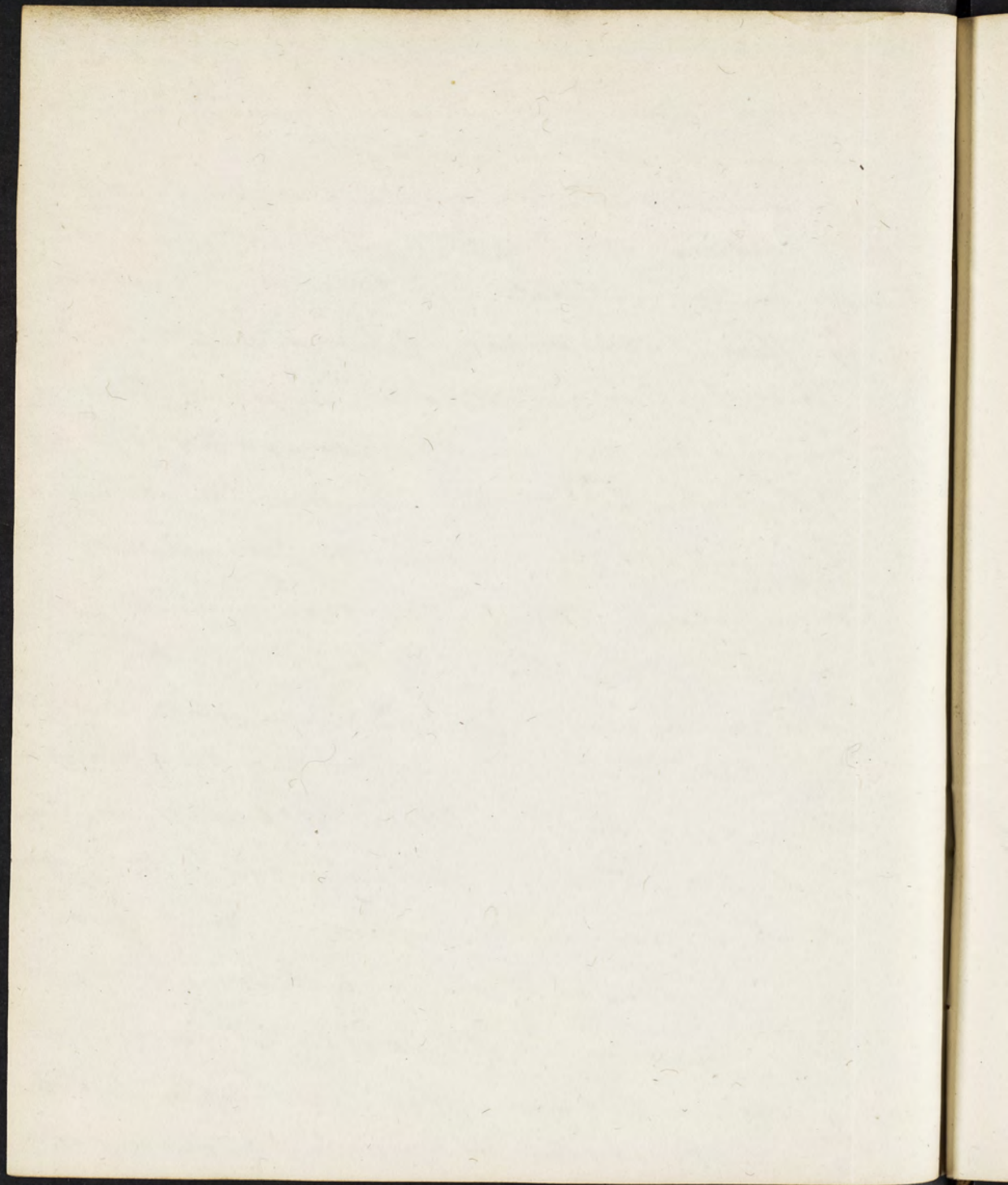
There are two principal circumstances, in which organised differ from unorganised bodies — the one is the faculty of breathing — the second that of digesting food. These must therefore depend on something peculiar to such bodies — How are we to account for these? It is first necessary to know the facts which are connected with respiration & digestion. Chemists & they only have pursued this subject so as to get at facts ^{from} which a reasonable theory can be built. But at present we know little more than the difficulties which attend the investigation — About the year 1688 in the reign of Charles the 2nd Dr Hooke & Dr Mayo first began to suspect, that the air taken ~~into~~ into the lungs is decomposed during respiration & that the part calculated to support combustion disappeared. Mayo first decomposed ex vitro. & procured an air in which animals would live & affirmed something like a conjecture, that



it was this air which was necessary for respiration -

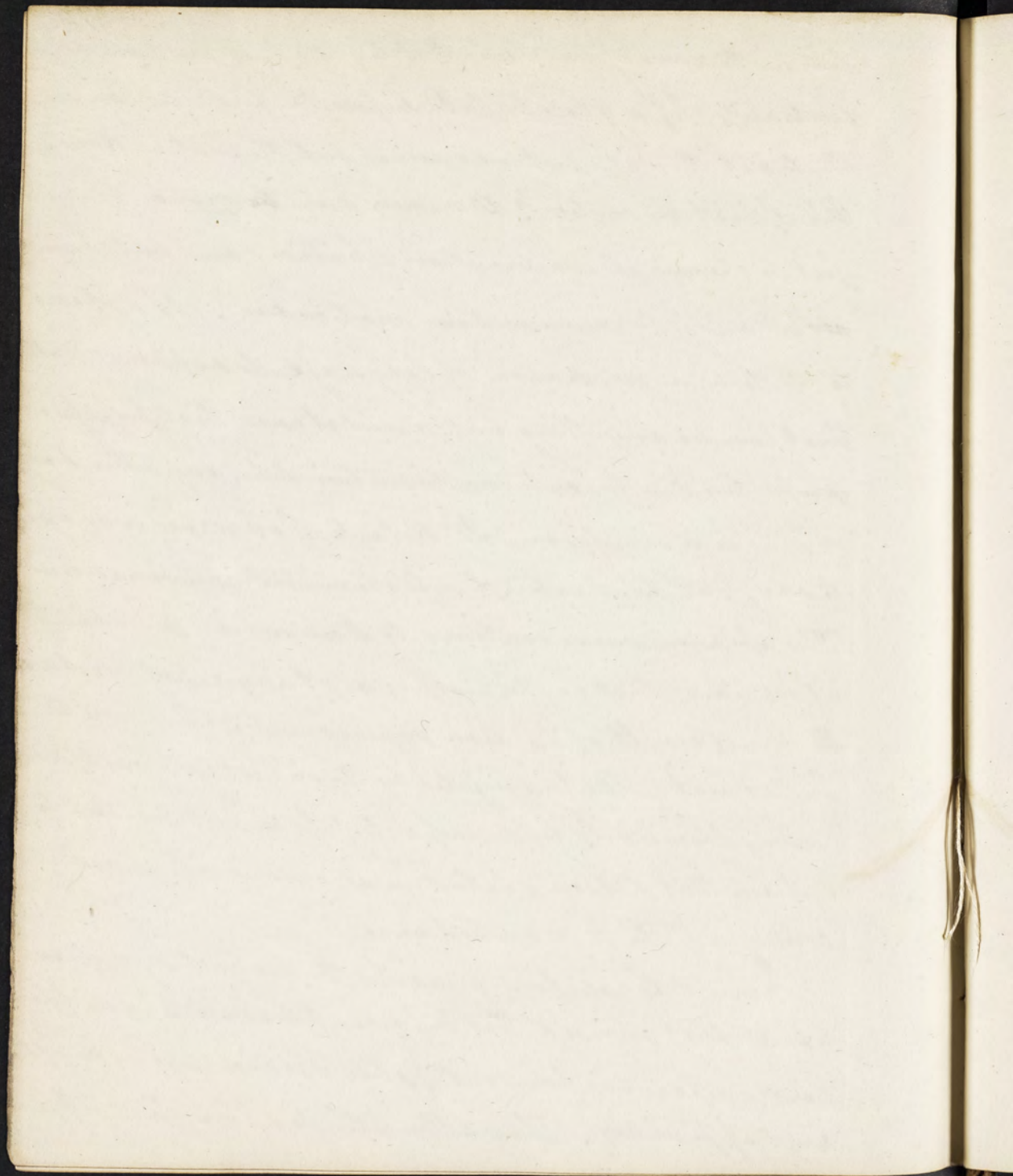
Black discovered that heat is a chemical substance, that when free its properties were evident, but that it might be combined with other substances, thus becoming latent. & that bodies in assuming different forms always combined ^{with} or gave out heat. This Dr. Black did not openly affirm but his experiments tend directly to this point.

That I believe to ^{be} a substance "sui generis". How any one can explain the chemical fact relating to heat, by words if they believe that it consists in motion - I am at a loss to determine. but there are one or two facts which are demonstrative on this subject. Some consider heat as consisting in the motion of the particles of bodies. Let such consider whether there can be a red colour - but of a body that is red - or blue, but of a body that is blue, motion is a property of a substance, not ~~the~~ substance itself. To say, that a property exists, independent of the body, predicated, is grammatical nonsense. Heat is sensible in every body. can the motion be the same in every body? is the motion in a piece of red hot iron - or gold the same as that in my skin? Can motion be latent in a body? Again we know, that when we put a



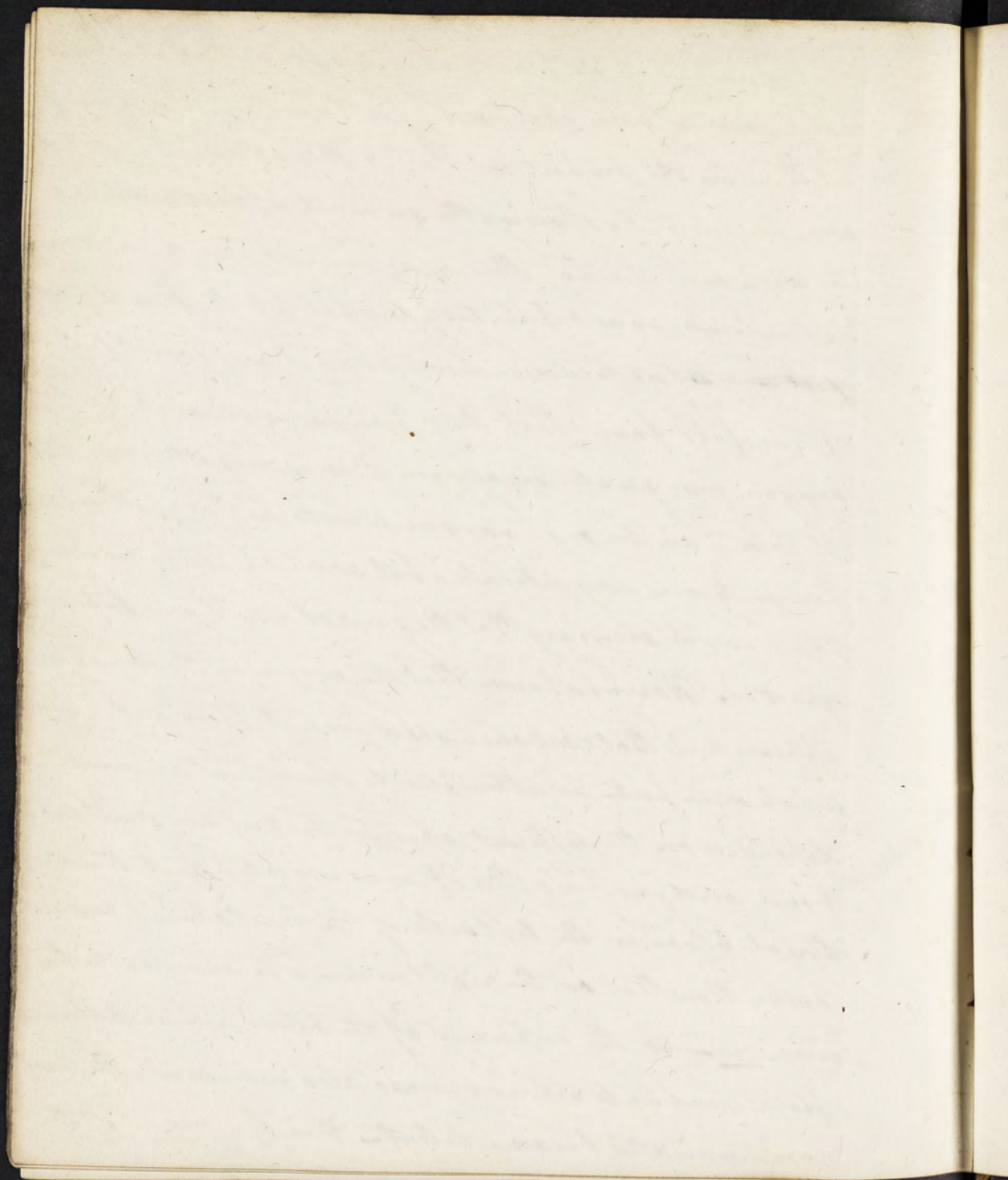
lens in the rays of the Sun - that light & heat are both concentrated. If a glass be held before the fire - we can see the light thro' it - but we cannot feel the heat. - How is this if heat be motion? Moreover can ~~be~~ motion be subject to chemical combination - bodies can - but I am ~~at~~ at a loss to conceive how motion can? It appears to me to be a perversion of language - to suppose, that heat can be any thing but a substance, that possesses properties & enters into combination like any other body. - This is a digression. Dr Black I observed, was apt to say, that heat entered into chemical combination. This opinion was so contrary to those which prevailed at his time - that he himself was staggered at what was the direct result of his own experiments - & therefore termed ^{manifest} latent heat. - But - appalled by the investigations of succeeding Chemists - & by new facts - I cannot hesitate to affirm that Black's latent ^{heat} - was caloric chemically combined with a substance.

Irving Crawford pursued the subject of respiration & first showed that different bodies had different capacities for heat - (still I said to say different affinities). I then attempted to show, that differ-

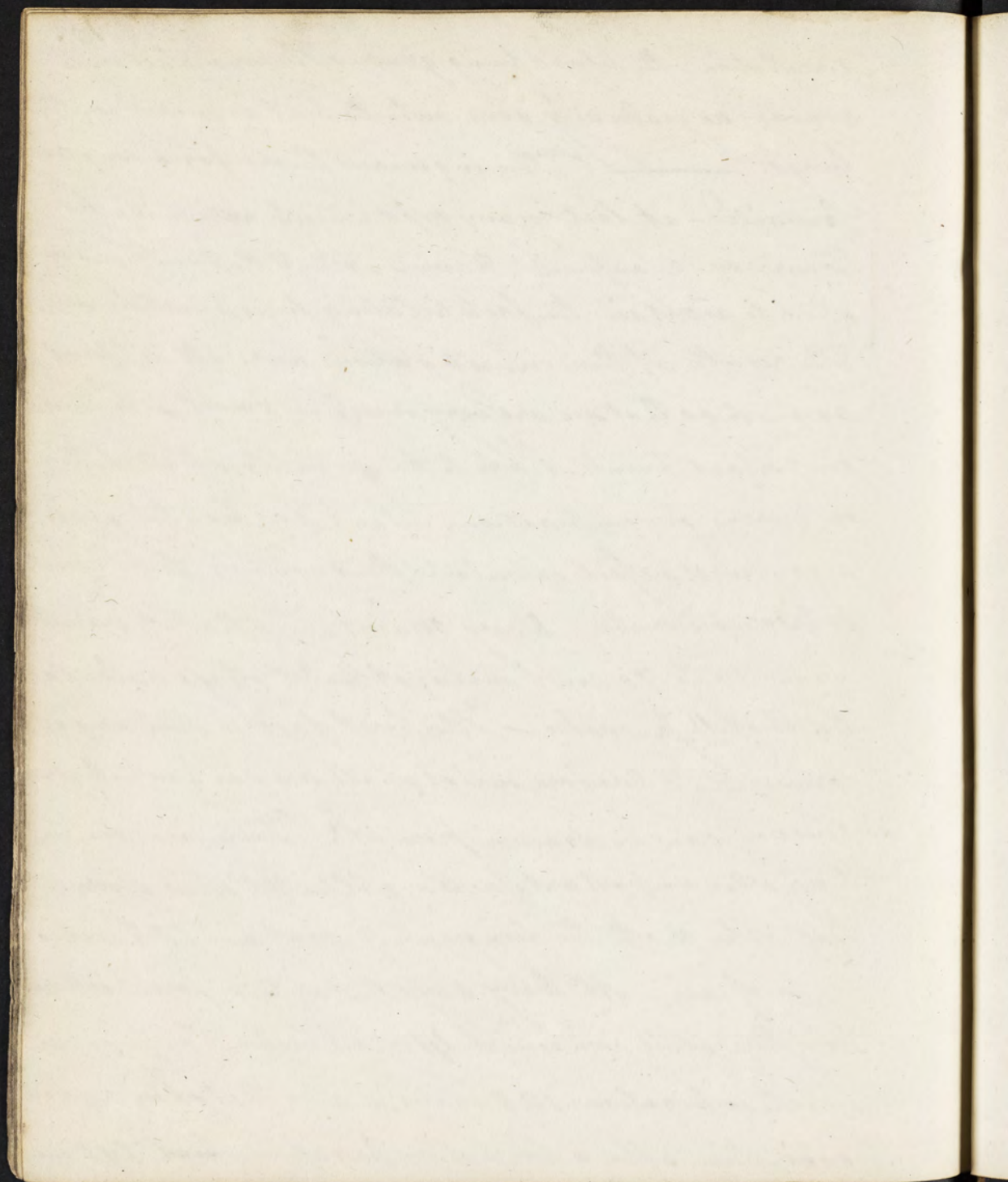


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-rent gases - had different capacities for heat - that is - that some gases - as gases, combined (for I must use the expression) with a greater proportion of heat than others. These experiments were pursued - by showing the quantity of heat given out by each one. & altho - these were conducted with great nicety & minuteness - so as indubitably to establish the general fact ~~that~~ yet as to individual gases, it was doubtful Crawford found, that the specific or absolute heat of oxygen was greater in oxygen than in any other air - that if comⁿ air be one - oxygen would be four. These experiments were very delicate - but so much confidence was placed in his accuracy that the general result was taken for granted. Having shown, that the oxygen in the lungs disappeared - & that carbonic acid took its place either in whole or in part - he attempted to show, that animal heat depended on the different specific heat of oxygen & carbonic acid gas. To this it was objected, that the arterial blood in the left side of the heart should be much hotter than that in the right side - The answer to this was - no - as the capacity of the blood while passing from venous to arterial - was also increased - the heat communicated became latent - & in the course of the



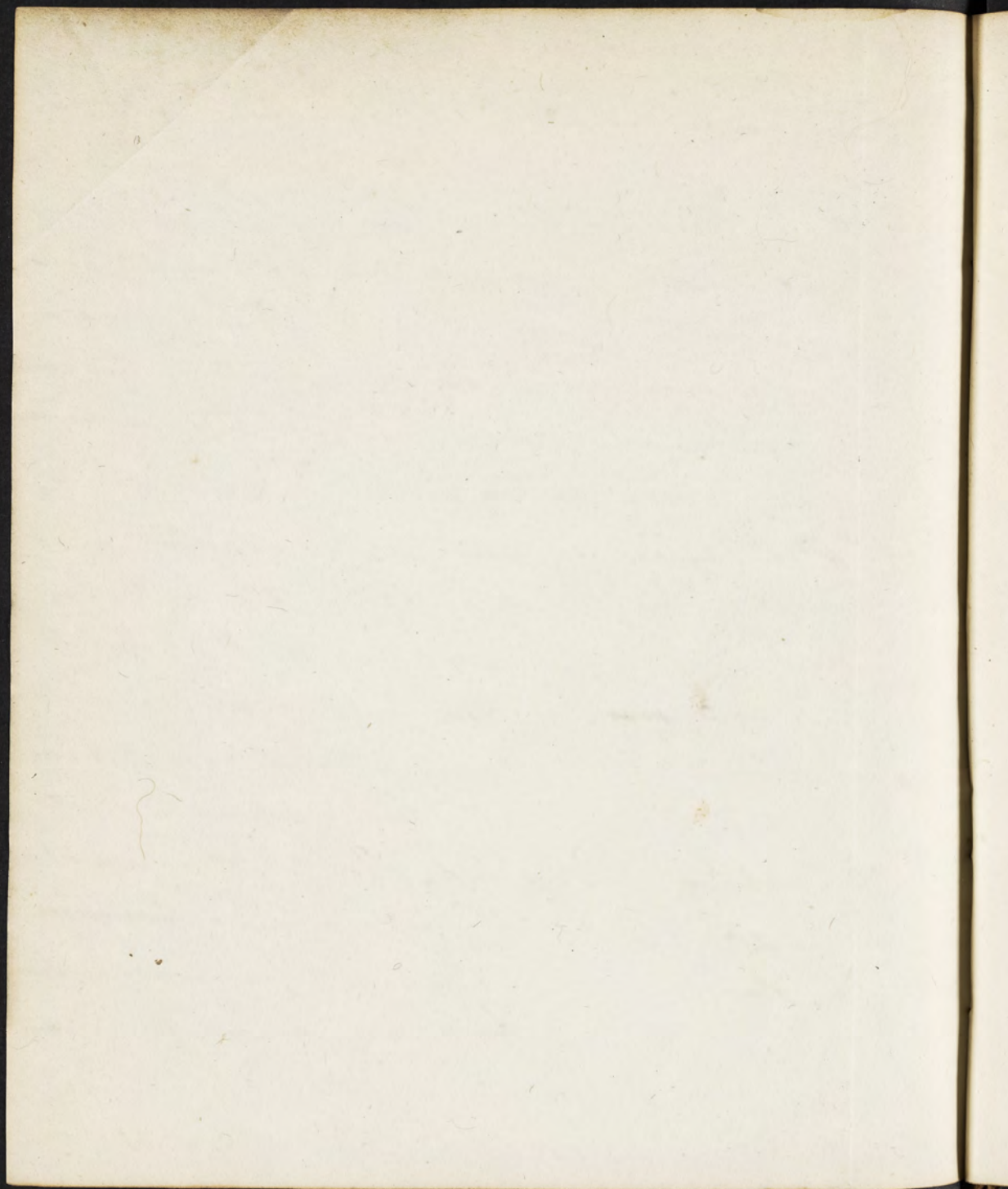
circulation - the blood being gradually converted into venous - as gradually gave out - the heat acquired in the lungs. — This ingenious theory for a long time prevailed - at last many experiments were made by Lavoisier. Laplace Davis - Allen & Pepys - & many others to ascertain the facts relating to respiration - The results of these investigations were all different so much so that we are very much in doubt as to several important points - ^{as to} the quantity of air taken in during one inspiration. Some by breathing into a confined vessel calculated the quantity to be equal to 40 cubic inches - Davy maintained that it varied from 13 to 70 cubic inches; Allen & Pepys calculated it at 16.5 cubic inches - This first fact is then undetermined - & therefore what shall we say? what conclusion can be drawn from it? There are one or two other important facts - Allen & Pepys observe that after death the lungs will contain 108 cubic inches of air - Dr Davy says that after a forced expiration, there still remained 41 cubic inches & after a natural expiration - 108 inches - also that ^{the} after a forced expiration after a forced inspiration - ~~that~~ 190 cu-



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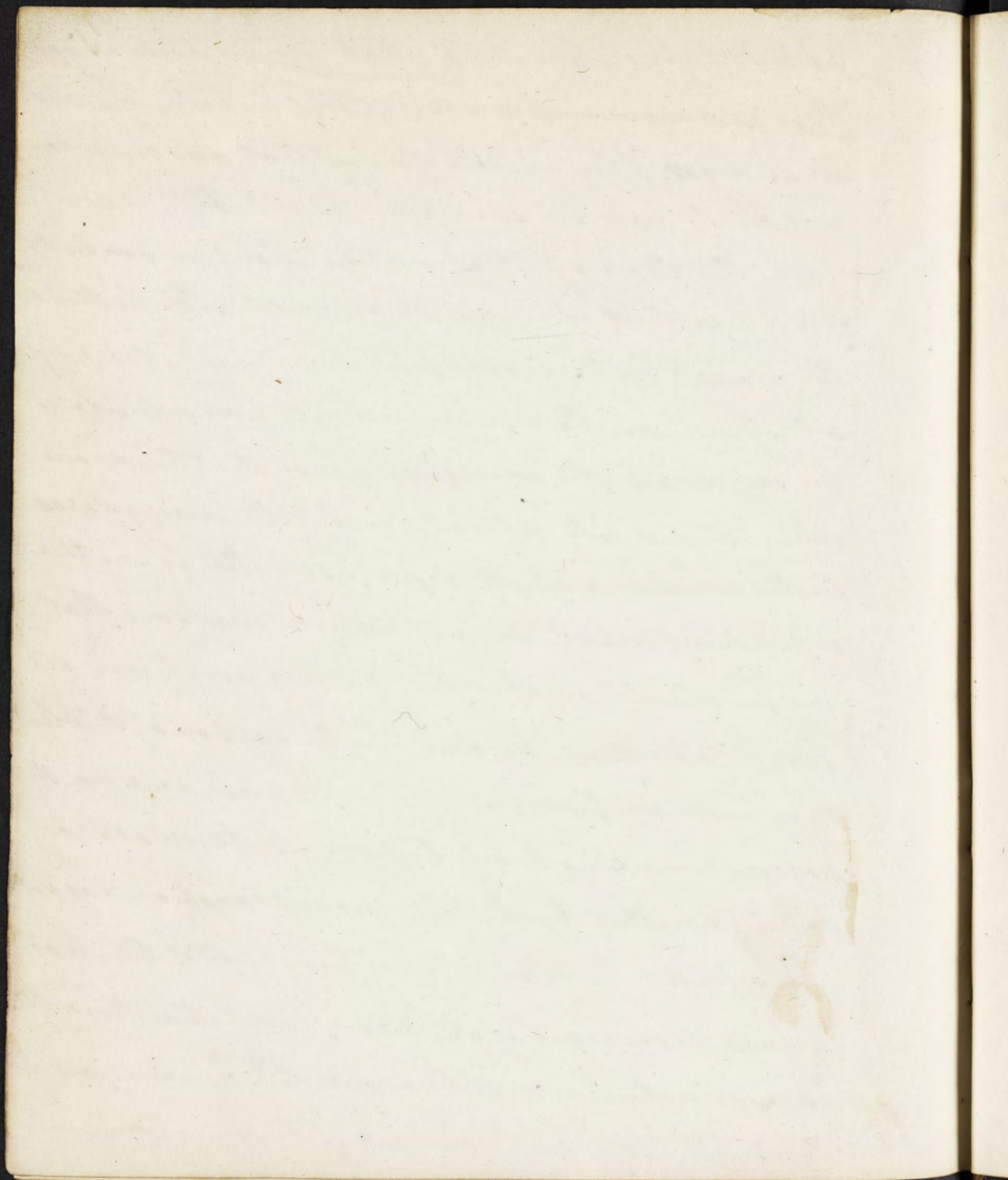
-bic inches were expelled; consequently according to him
the lungs contained 231 cubic inches of air - Allen & Re-
-pys however made it but 108 - (How can we account for
this difference?) - The next question is how often does
a man inspire in a minute - during an easy respiration.
The authorities on this point differ as widely as on
the others - nothing can be deduced from them. I can on-
ly give you what are considered as facts - & you see, how
much we are in the dark. - The next inquiry is.

What changes are effected during respiration? what
are the results of the experiments on this point - Lavoisier
& Davy do not disagree very much - they calculate
that $31\frac{3}{4}$ ~~for~~ cubic inches of oxygen are consumed in
a minute - but it is manifest that there can be no cer-
tainty in these calculations till it is determined what
quantity of air is inspired. If I take the chance of rea-
-soning on this subject, I would depend on Lavoisier
who ~~has~~ executed experiments with more accuracy than
any one I know. Well then so much oxygen is con-
sumed what becomes of it? Davy & Lavoisier say
that the quantity of oxygen disappearing is $31\frac{3}{4}$ inches

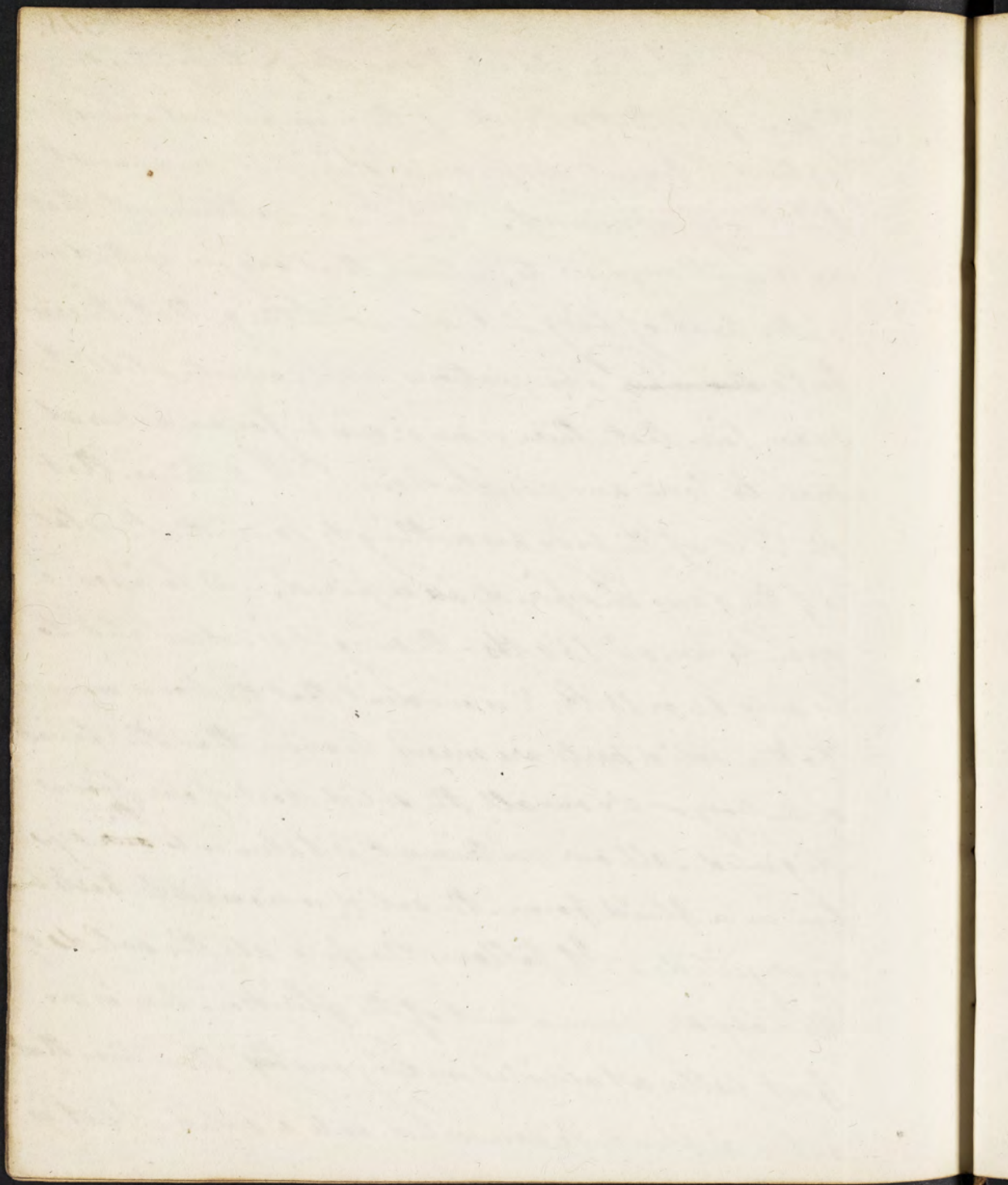


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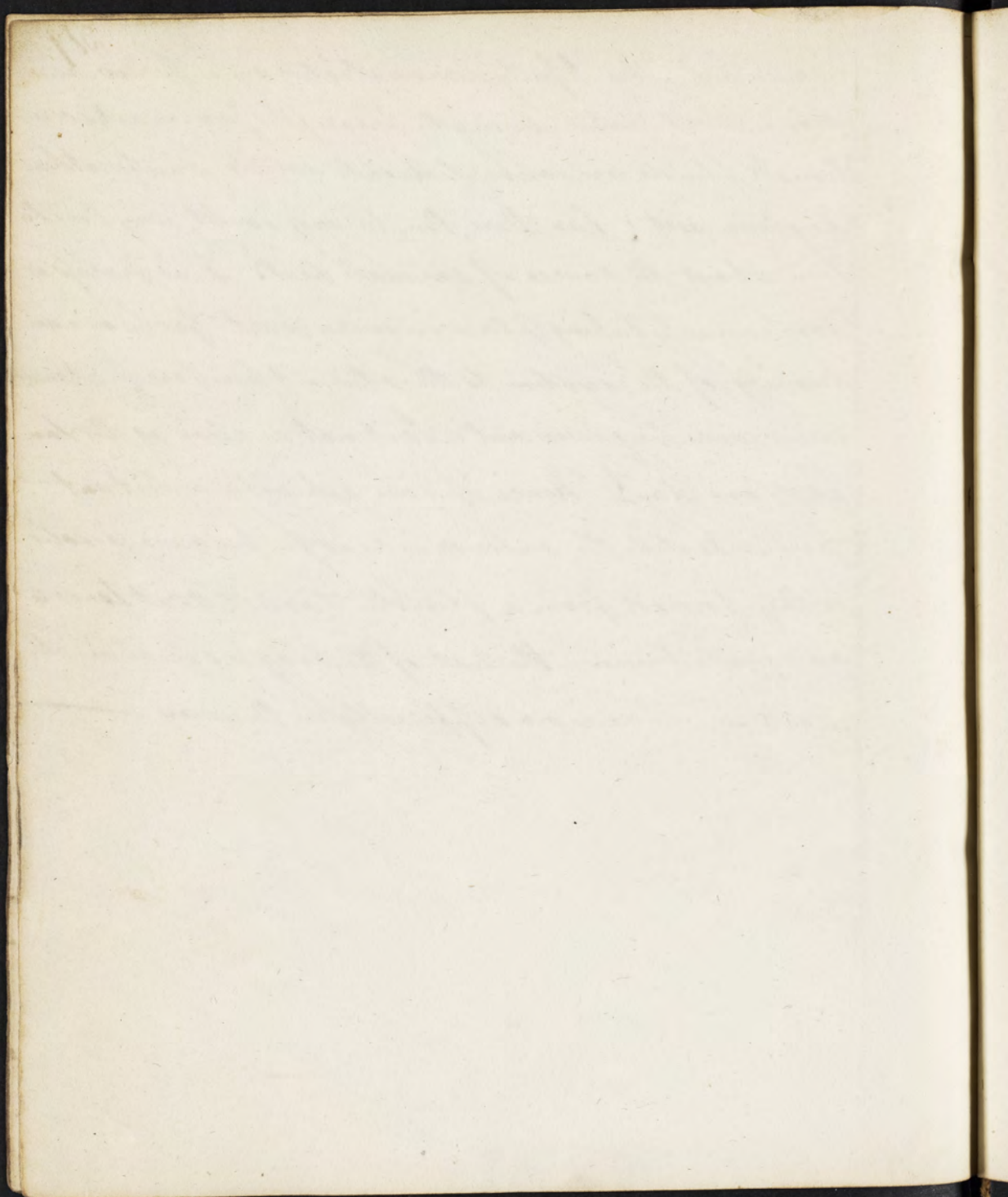
Allen & Pepys make it 26 - both parties however agree
that the oxy gen inspired is replaced in bulk by carbonic
acid gas. Then we have the fact that oxy gen is con-
verted into carbonic acid gas. Well there is another
fact - The theory of the absorption of oxygen ~~gas~~ by the
blood was first advanced by Priestley. He filled a
thin bladder with venous blood - & immersed it in a ves-
sel of mercury. The mercury was afterwards displaced
by oxygen gas - the consequence was - that the venous
was changed into arterial blood - & the mercury rose
in the vessel in a slight degree. Here then is another
experiment which does not render it necessary, that
oxy gen should be absorbed & which overthrows all
Crawford's theory - because here the carbon of the blood
may unite with oxy gen - & form carbonic acid gas - the
volume remaining nearly the same - but how carbon
can be emitted by the blood, no explanation has yet
been offered - Allen & Pepys thought that there was
a small increase of ex. Nitrogen - whether this is the
case or not - has not been decided. These are the
material facts on the subject of Respiration -

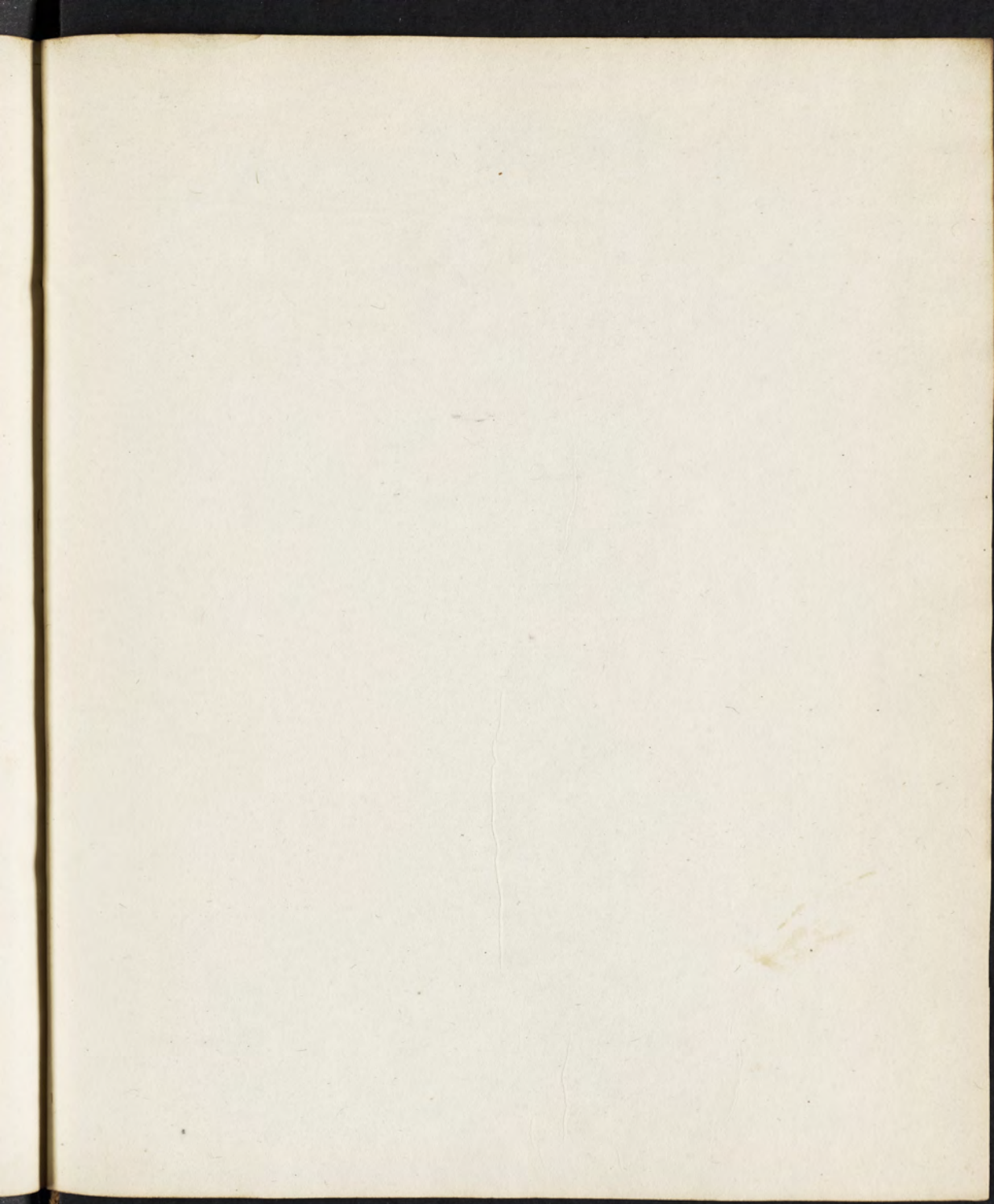


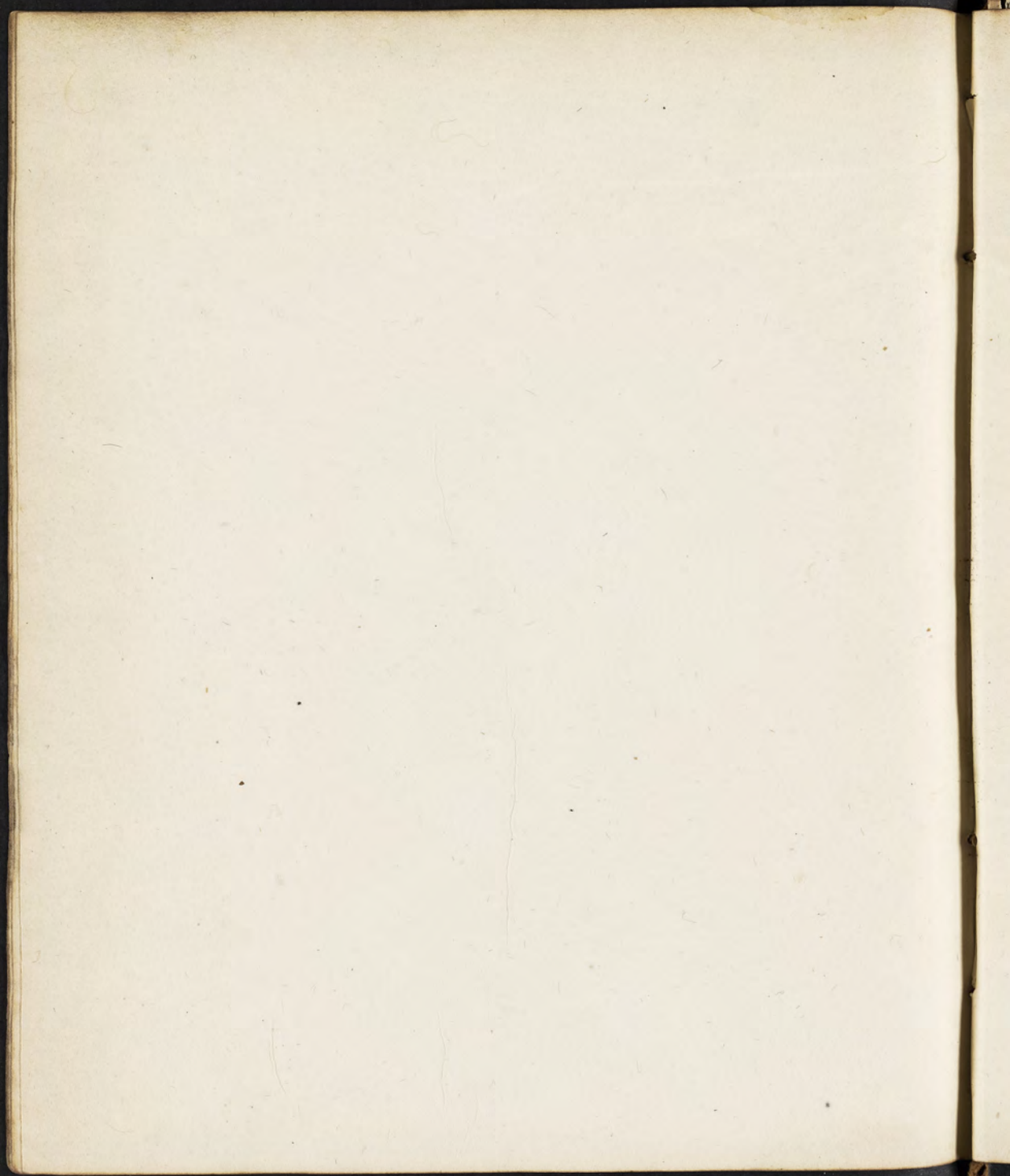
Well - I have detailed you the facts on this subject
 & you find that on each of these important investi-
 gations Chemists differ so widely, that we cannot
 trust any experiment. There is no experiment that
 will authorize us to believe that any gas is the cause
 of the heat of body - Even admitting that Crawford's ~~former~~ observations were correct - still I
 maintain that - there is no ground - for an accurate
 man to form any conclusion - I believe that
 the heat of the body has nothing to do with the state
 of the gases inspired ~~and~~ expired. - Suppose a
 man to weigh 2150 lbs - ^{or} the weight is calculated to
 be only 14 or 15 lbs. & is evident that the bones, muscles
 & other solid parts are much heavier than the fluids
 of the body - Now all the solid part of our food is
 digested - all our nutriment is taken into ~~the~~ ^{the} sys-
 tem in a fluid form - the solid, indigestible parts be-
 ing rejected - It follows therefore all the solids of
 the body are formed out of the fluids. There is no
 fact better established in Chemistry - than this - that
 where a fluid is converted into a solid - heat is

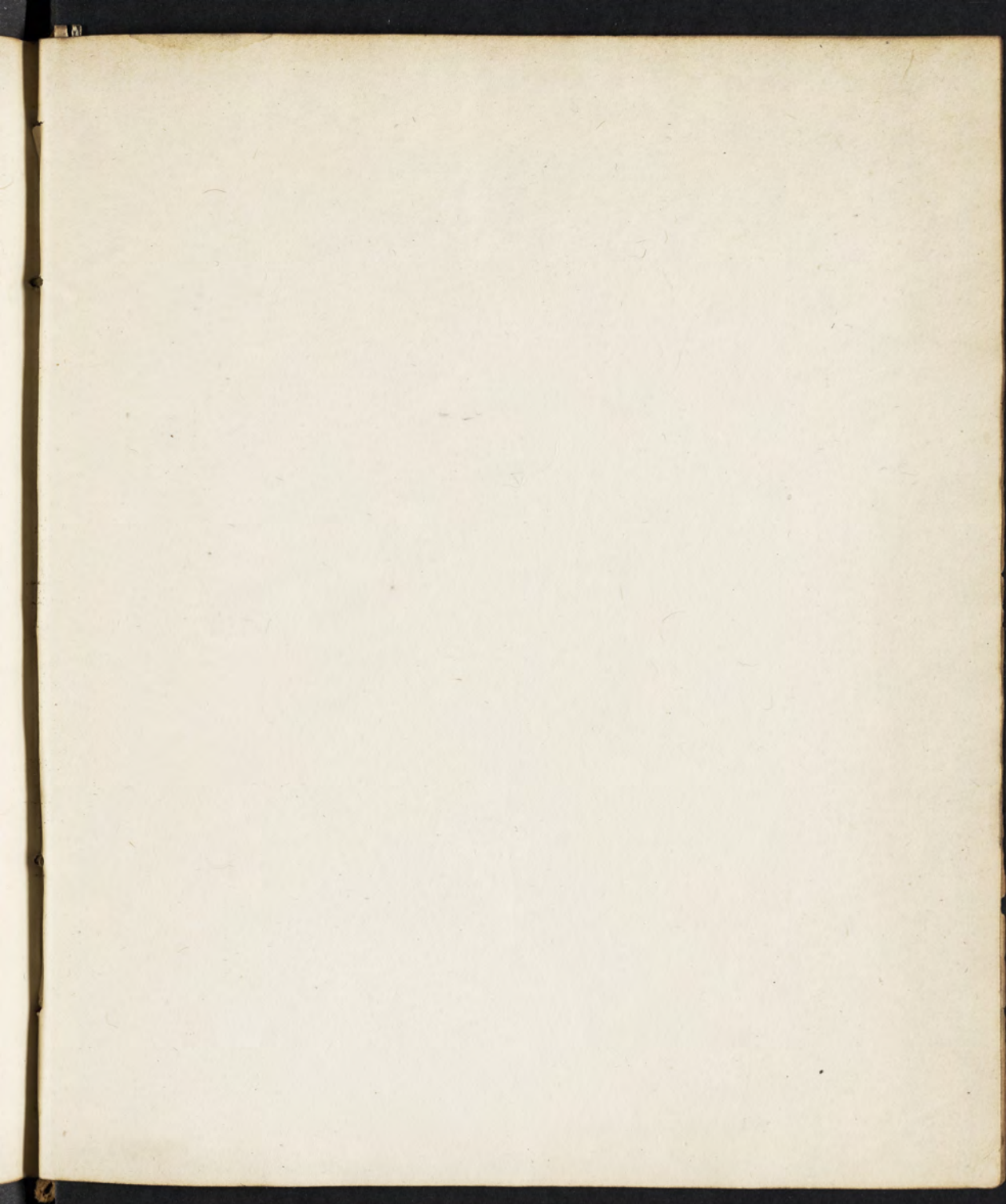


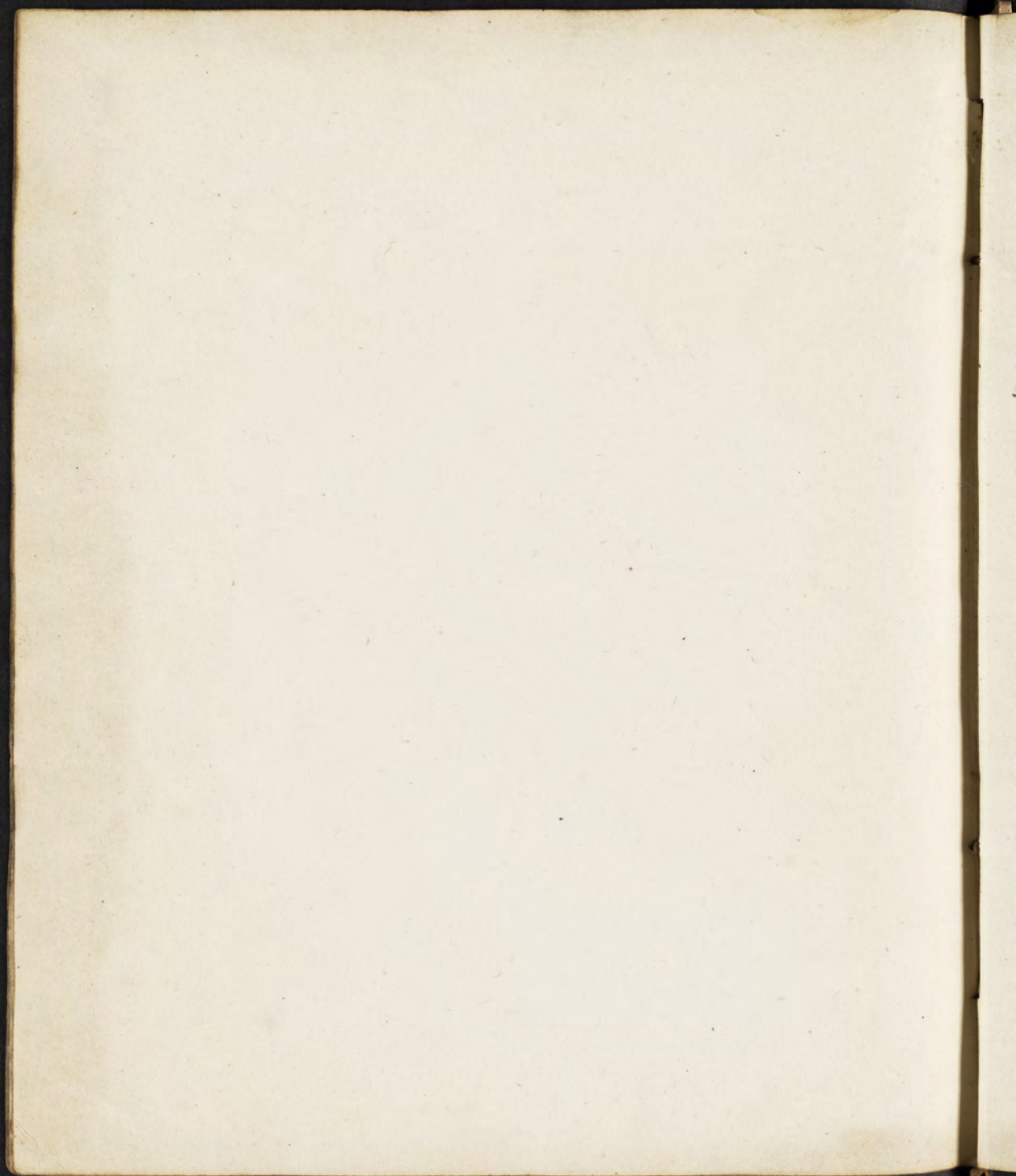
given out. This I fully demonstrated on a former occasion. Well - when during the progress of animal secretion the fluids are converted into solids - must not heat be given out? Can there, then, be any doubt, any hesitation about the source of animal heat? This process is continually taking place in every part - from one extremity of the system to the other - & therefore heat must every where be given out - Is it not as clear as the Sun at noon day? Hence if you ask why a distant part is heated - the answer is ready - because a solid is there formed from a fluid - & as all heat tends to an equilibrium - the heat of the body is equal in all parts - There is no difficulty in the way -

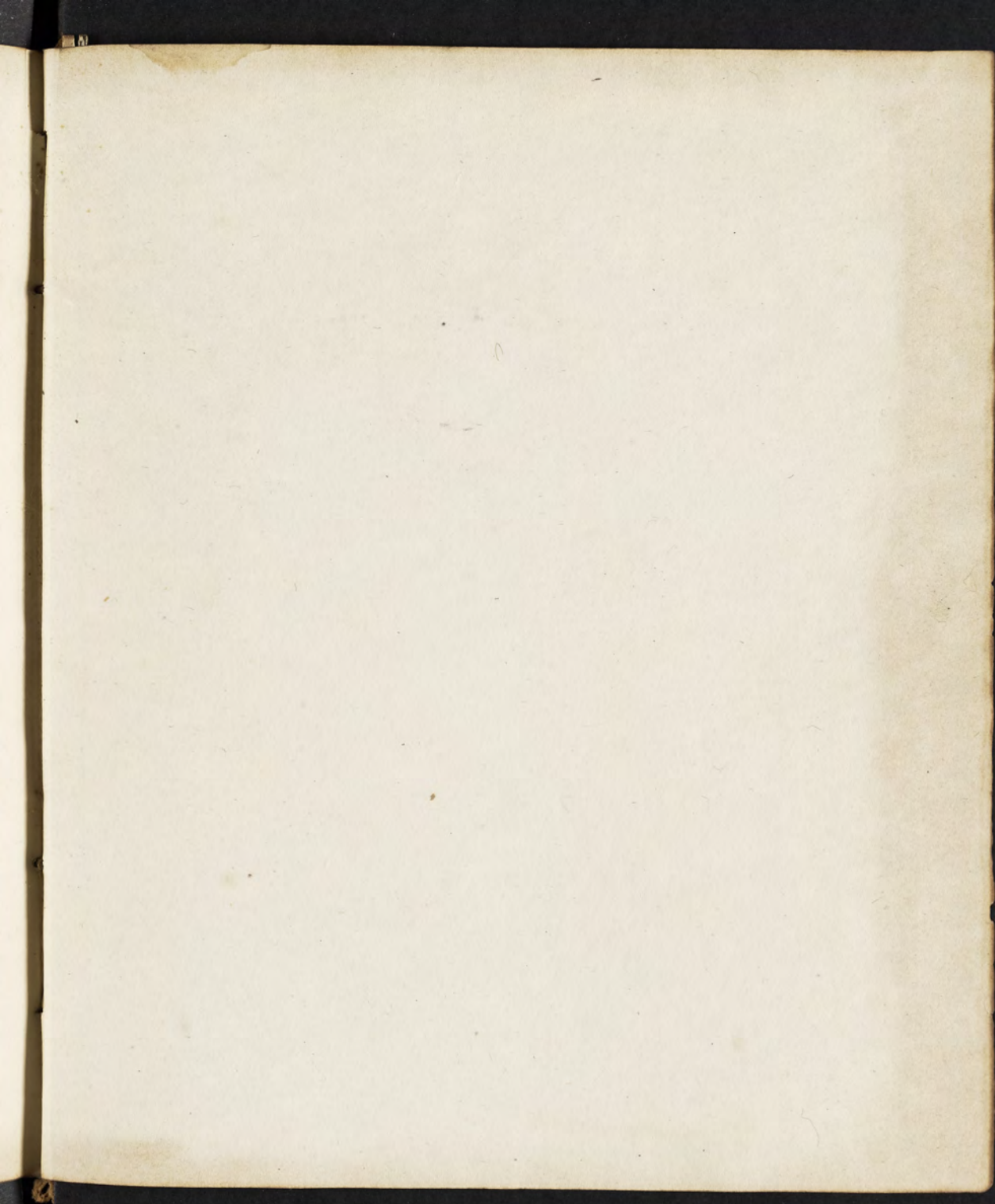












254.2 ---

Potash
felt spar?

From 1800 tons - dry oak
1 ton of Potash

1200. Hickory 1 ton -

Thin more - grass cut -
Barnet - all wood which
contains resin have eaten
none -

Procured in Europe from
Ruff - Norway Amer.
Can? to the ports Riga Danzig
14th - oak. 4 - Hickory. 5th

Potash in Lye coming
County -

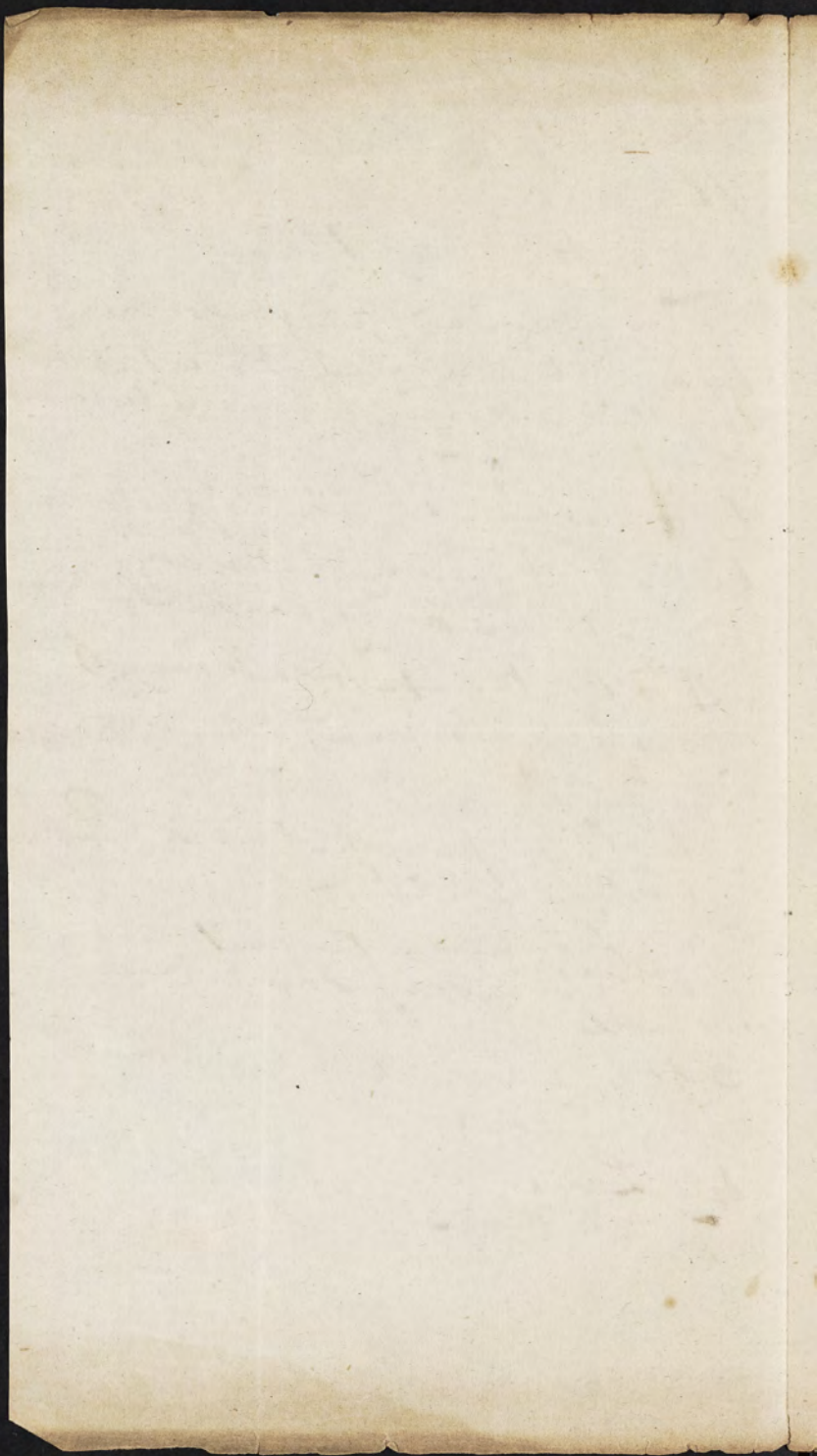
Potash precipitates Platina
Vodas will not

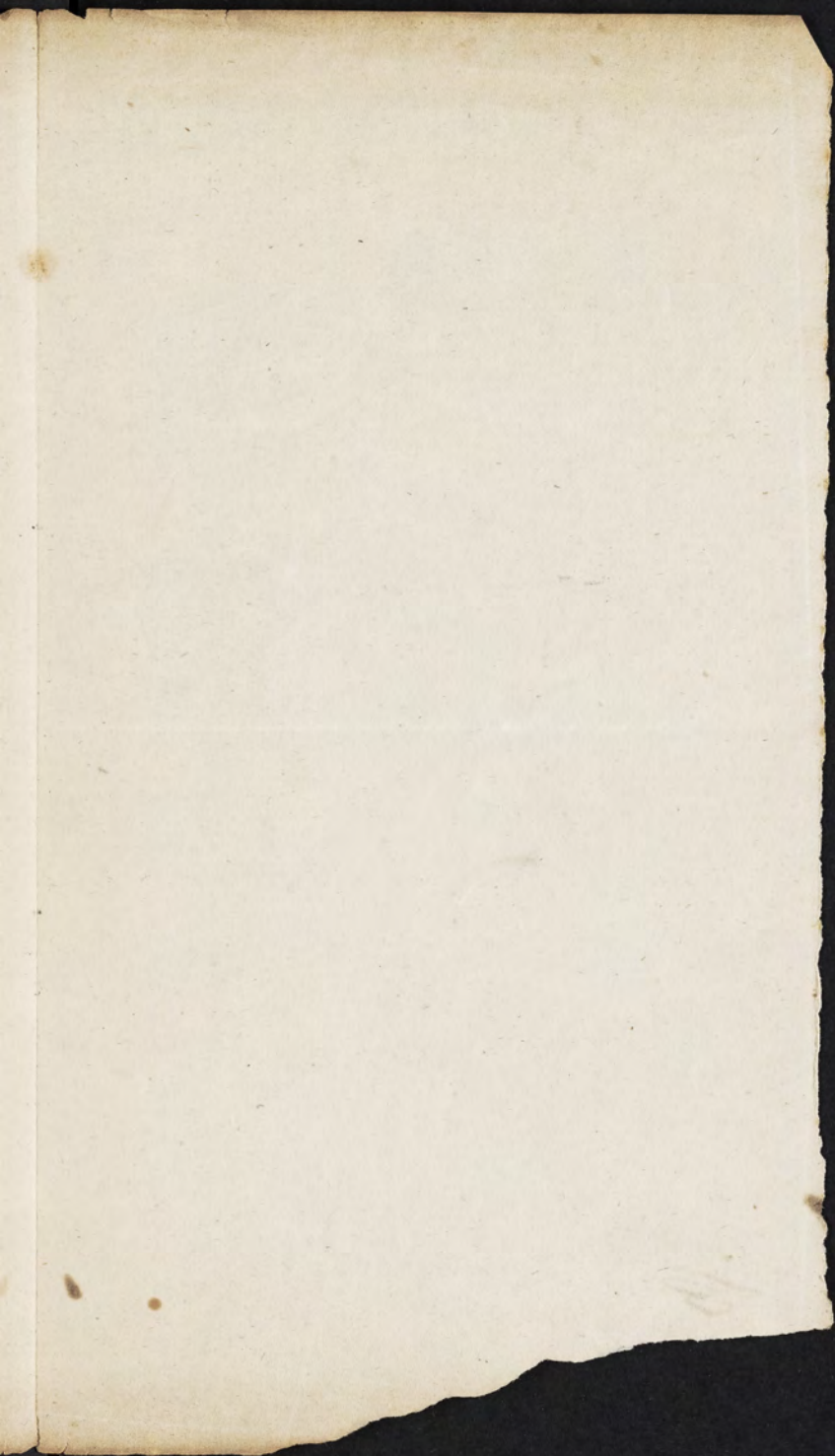
acid of Tartar with on 1 part
of Potash - insol. Soda very
soluble

Digest of animal sub. produce
Carb. Ammon?

44 Lime
7.20 mag.

281
670
177
107
07





In all cases

keeping the grain moist
for 30 or 40 hours until
it swells - it is then
placed on a floor until
it germinates - it is
then dried to prevent
this process from proce-
ding -

3 B

~~14897~~ 51425 C



Class 10a No 36

Presented by
Mr. Hugh Lenox Hodge

